CONWAY

A new locomotive by Martin Evans

A freelance narrow-gauge saddle tank locomotive for 3½ in. gauge

Part I

Introduction

MANY OF OUR READERS have asked for a simple but powerful narrow-gauge locomotive, preferably for the 3½ in. gauge, that would not take too long to build, and one for which the essential castings, especially those supplied in gunmetal, could be kept to the minimum. Generally speaking, a nice narrow-gauge engine can be built with very few castings, even such things as cylinders and axleboxes can be built up, and mild steel sections could be used in place of cast hornblocks.

It is certainly quite a long time since a genuine narrow-gauge type was described in *Model Engineer*, although narrow-gaugers have several advantages over their bigger brethren. For one thing, the cabs are invariably much wider than on any standard gauge locomotive for the same rail gauge. The boilers on the full-size narrow-gaugers were generally of quite simple design, low pitched, small barrels and high-pitched round-topped fireboxes rather similar to the early "hay-stack" designs. Cylinders were generally outside, often with the valve chests inside the frames, and, as the driving and coupled wheels were of small diameter, the motion was low pitched, necessitating cylinders arranged inclined. The valve gear used was more often than not Stephenson's link, with locomotive-type links and hand-lever reverse in the cab, though Hackworth valve gear was occasionally used.

Narrow-gauge locomotives were generally supplied to contractors and owners of quarries, coal mines, etc., especially towards the end of the nineteenth century. One reason why they were often preferred to standard gauge locomotives was not because of any intrinsic advantage in themselves but because the narrow-gauge permanent way was so much cheaper. The rail section used was generally much lighter than on the 4 ft. 8½ in. track, the sleepers were much shorter and often more widely spaced, and the amount of ballasting, the provision of drainage, etc. etc., was a great deal less. In view of the fact that so many narrow-gauge locomotives worked in North Wales, I am naming our 3½ in. gauge model *Conway*.

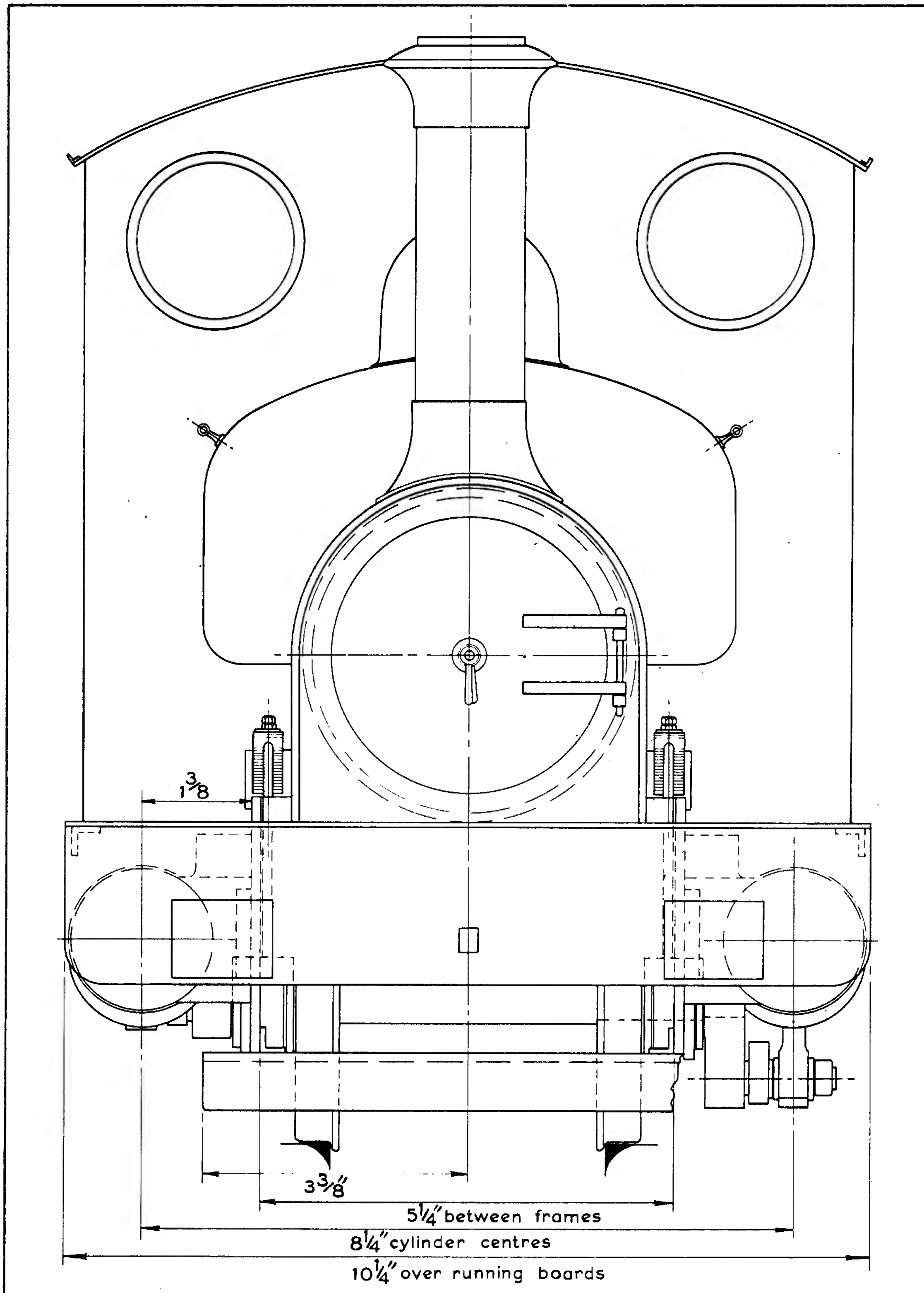
Designing a narrow-gauge locomotive for the smaller gauges is a very different proposition than designing a standard-gauge engine; in some ways it is easier, especially if the model does not have to be a fairly close scale version of the full-size locomotive. There is far more space between the frames, allowing the use of wide eccentrics and substantial links and pins, adequate bearing surfaces on axle boxes, horns, etc.

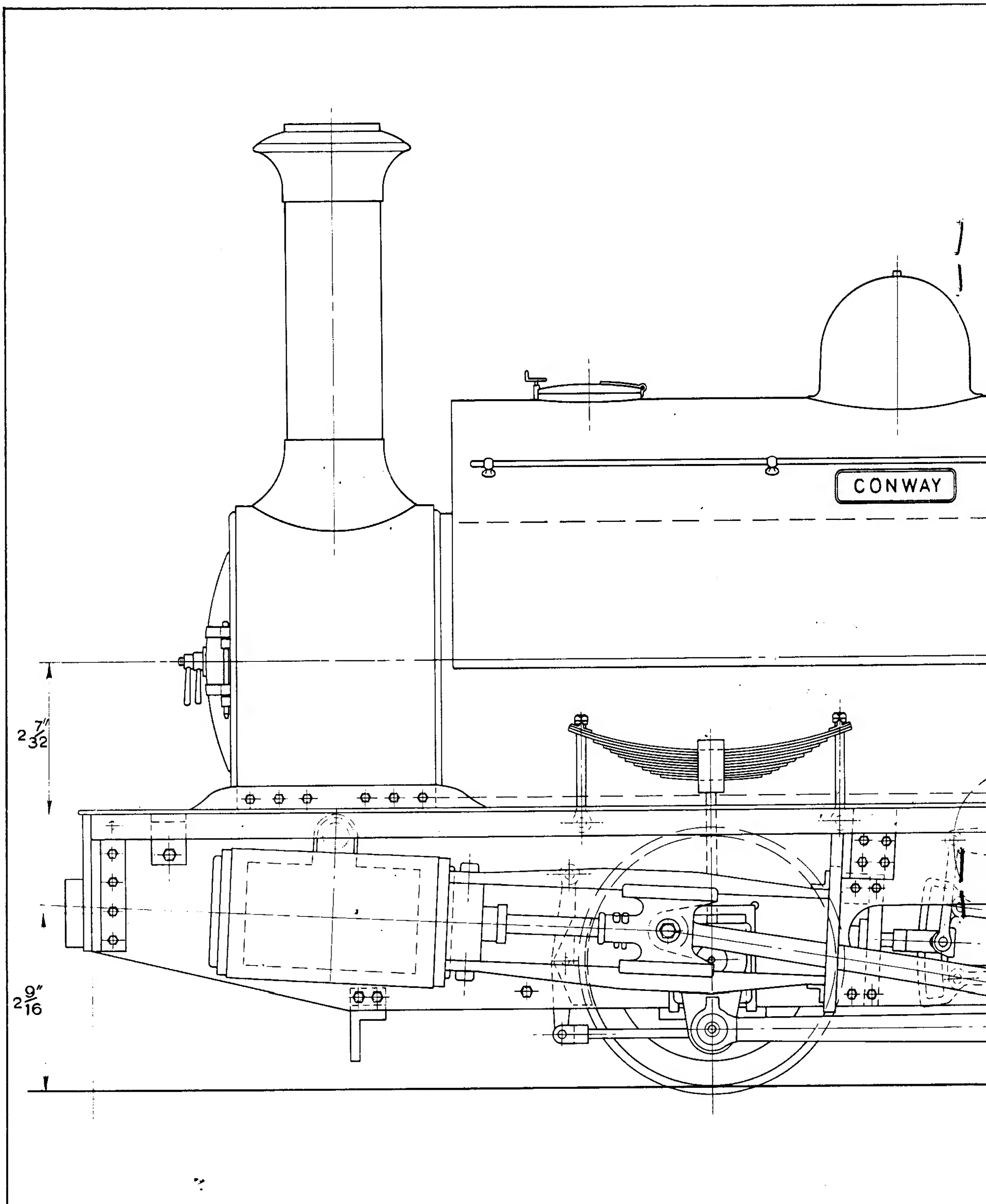
As I mentioned earlier, *Conway* is a free-lance engine, though in drawing it out, I have incorporated many of the features found on some of the narrow-gauge engines made by well-known companies such as Hudswell Clarke, Hunslet, Chapman & Furneaux, etc. The slide valve cylinders are 1 3/16 in. bore by 2 in. stroke, with the steam chests inside the frames. The valve gear is Stephenson link with launch-type links and centre suspension. I originally intended to use locomotive-type links, but found that these required rather a large throw for the eccentrics, and also, when in full backward gear, came very close to the underside of the boiler barrel, which I was loath to raise for fear of spoiling the appearance.

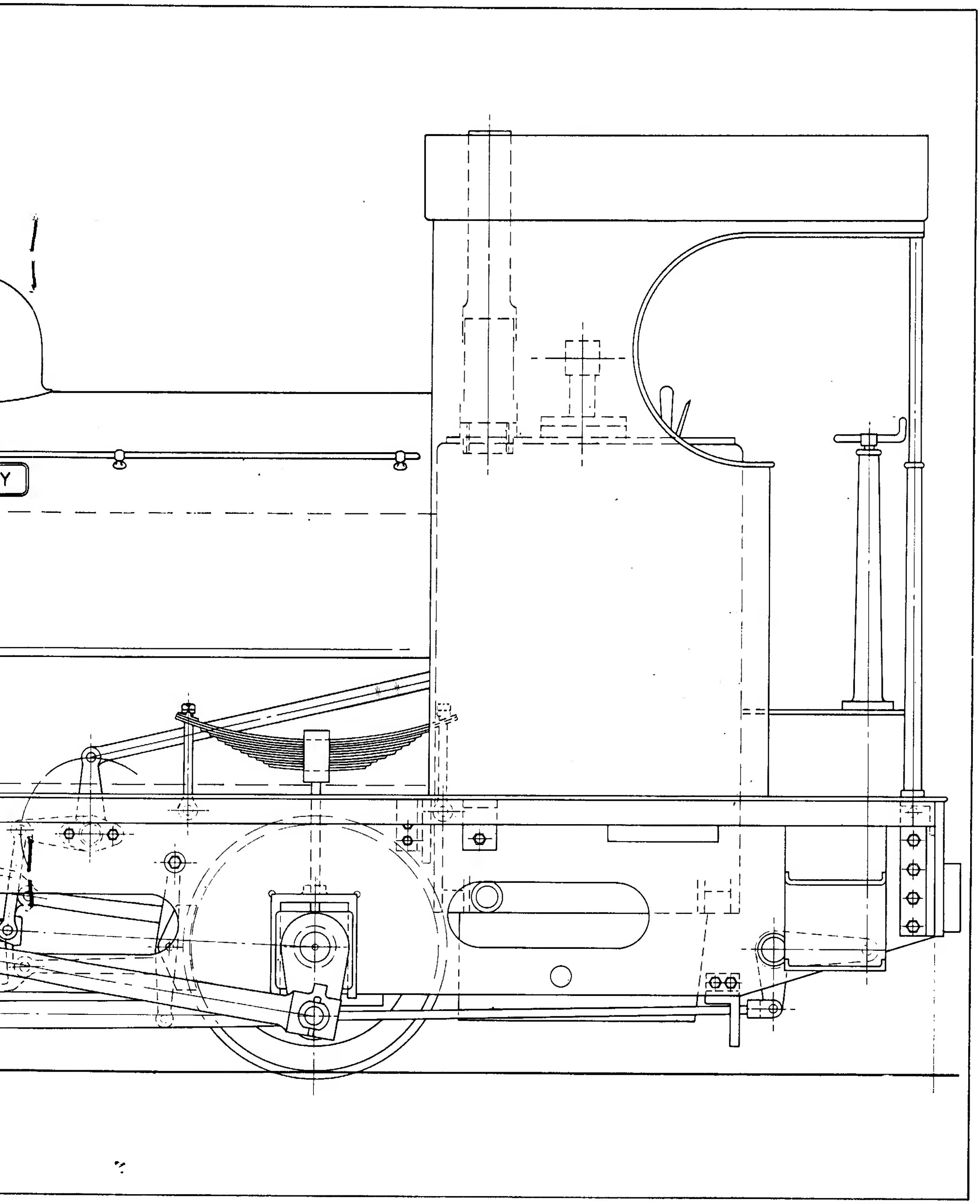
The boiler will be a simple coal-fired round-top type, with the raised firebox as mentioned earlier. A single firebox type superheater will be specified, although I appreciate that no full-size engine of similar type would be superheated. But a mild degree of superheat is invaluable in a 3½ in. gauge model, cutting out excessive cylinder condensation and making the locomotive much more lively.

The frames will be 1/8 in. mild steel set 5¼ in. apart, and hornblocks are used and split axleboxes, which will be found much more convenient than solid boxes on an outside-frame engine, though rather more work to make. A simple hand brake will be specified, which is always useful if the locomotive has to be left on the track unattended at any time. "Dumb" buffers, which are nothing more than rectangular slabs of steel, will be fitted, though the couplings can be left to the preferences of individual builders.

Let us now start straight away on construction,


1 3/8
3 3/8"
5 1/4" between frames
8 1/4" cylinder centres
10 1/4" over running boards


CONWAY
$2\frac{7}{32}''$
$2\frac{9}{16}''$



commencing with the frames, which are cut from 3½ in. × 1/8 in. bright mild steel, the widest, or rather the deepest part of them being 3¼ in., which will enable us to saw away the extreme edges of the material which are so often distorted in the manufacturer's shearing operation. After de-greasing and cleaning up with medium grade emery cloth, it is well worth while spraying one of the frame plates with a blue marking-out fluid, as scribed lines show up so much better than on the bright steel. File the bottom edges of both plates straight and true, checking against straight-edge or 24 in. steel rule, whichever is available, then, starting on the "blued" plate, mark off each end of the frame from the drawing, and the centre-lines of the two axles, following up with the sloping bottom edges at each end, and the raised part of the frame above the cylinders.

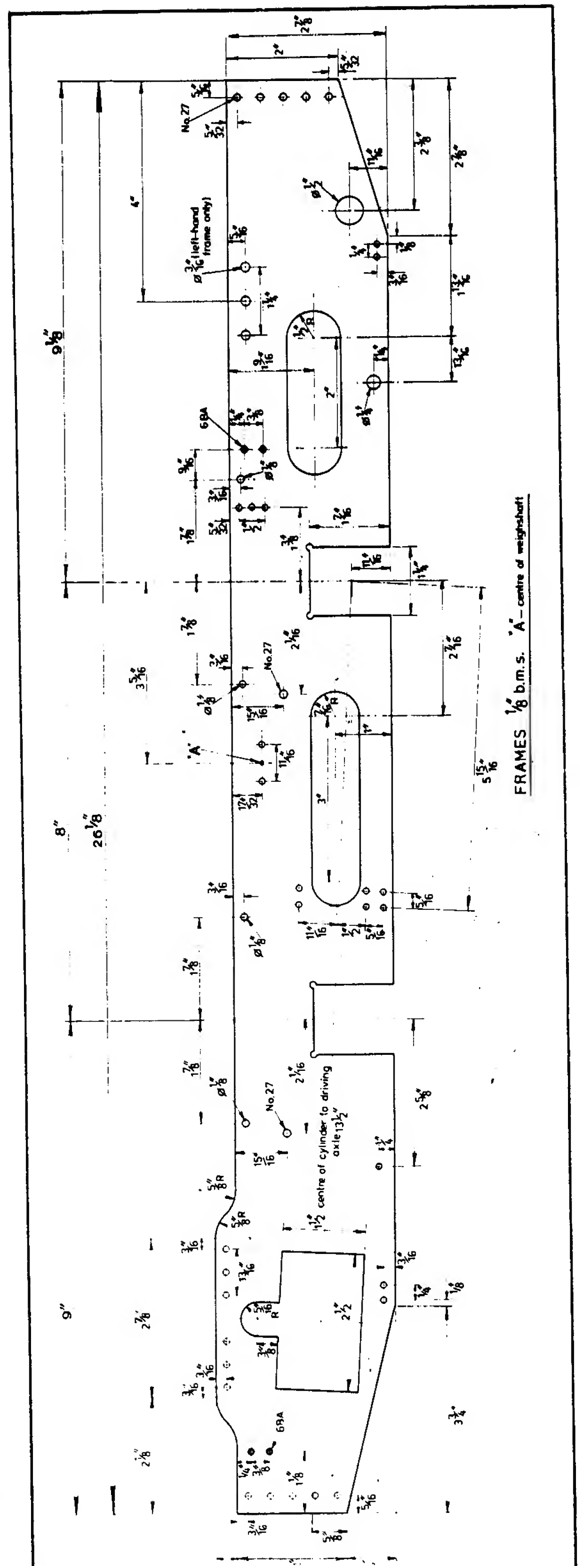
To mark out the inclined centre-line of the motion and the large rectangular opening through which the steam chest is fitted, mark off the centre of the driving axle; this is at 11/16 in. above the bottom edge of the frame. Then mark off a point on the front line 1½ in. above the bottom edge. Scribe a line from this point to the driving axle centre and this is then the centre-line of the motion. The cylinder opening can then be marked off from this, knowing that the centre of the cylinder is 13½ in. from the driving axle centre.

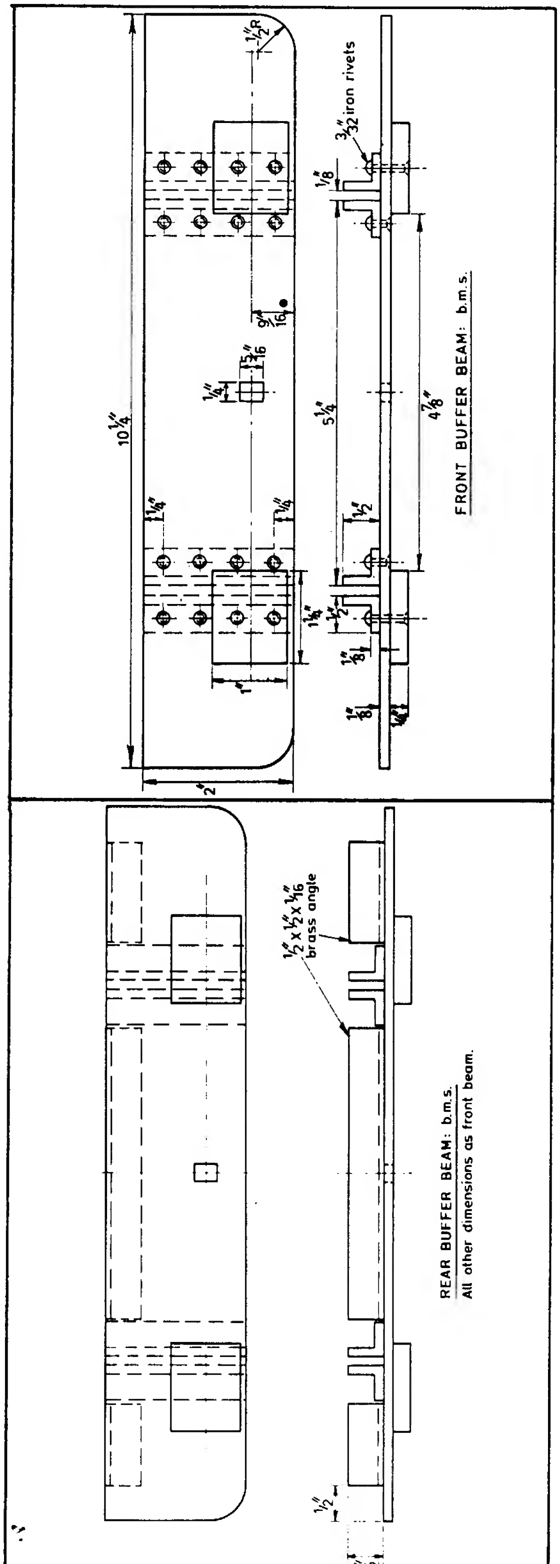
Next, mark out the openings for the hornblocks and the positions of the various holes. That for the weighshaft should be located with care, and note that the three 3/16 in. diameter holes for the cab reverser stand are drilled in the left-hand frame only.

Regarding the other holes to be located, the two No. 27 situated at 2 1/16 in. ahead of the driving and coupled axle centres and at 15/16 in. below the top edge of the frames are for the brake hangers. The single No. 34 hole at 2 5/8 in. ahead of the leading axle and at ¼ in. above the bottom edge is for a simple round frame stretcher. The groups of two No. 6 BA tapped holes near each end are for brackets to support the running boards. The four 1/8 in. diameter holes (one each side of the leading and driving axle centre-line) are for brackets supporting the main spring hangers (as can be seen in the general arrangement drawing).

The vertical row of three No. 34 holes at 1 3/8 in. to the rear of the driving axle centre are for another frame stretcher. The ¼ in. diameter hole underneath the rear large oval cut-out is for a grate and ashpan "dumping pin", and the ½ in. diameter hole to the rear of this is for a bush for the hand-brake cross-shaft.

The next thing to do is to rivet the two frame plates together, and for this the best holes to choose are the two brake hanger holes and the rearmost 1/8 in. spring hanger hole, as all three are 1/8 in. diameter and we can use 1/8 in. copper rivets. Countersink these three holes *very lightly*, then we can hammer the rivets in





and file them flush, so that the pair of frame plates can be held in any position in the bench vice without screw heads or nuts getting in the way. The holes are now drilled through both plates, with the exception of the reverser stand holes, as mentioned earlier, and the outline of the frames sawn and filed to size.

The two large oval holes, which in a full-size locomotive would probably be partly to reduce excessive weight and partly to give access to some of the oiling points, are best dealt with by drilling rows of holes about 3/32 in. diameter all round, close to the scribed line, then breaking out the unwanted metal and filing to shape. The rear opening will be useful to us as it will give access to the blow-down valves which will be placed on either side of the firebox immediately above the foundation ring.

There are only three frame stretchers, the round one mentioned earlier, a stretcher which acts as the inside motion plate, having long bushes to guide the valve rods; and the stretcher immediately ahead of the firebox. Usually, I like to carry this last-mentioned stretcher right down to the bottom of the frames, to give protection to the valve gear, but unfortunately, this proved impossible with the outside frames, the driving wheels being in the way, short of moving the firebox even further to the rear. But to ensure that the frames are really rigid, further support is given by the fitting of steel angles across the frames at each end of the locomotive, although the primary purpose of these angles is to prevent damage to the locomotive in the event of a derailment. Without these attachments, a derailment would almost certainly cause damage to the brake gear and possibly to the connecting rods, as the whole engine is very low-built.

The buffer and drag beams are cut from 2 in. × 1/8 in. b.m.s. They are alike, apart from the addition of the angles fitted along the top edge of the drag beam, which are to support the rear end of the running boards and the footplate. The frames are attached to the beams by ½ in. × ½ in. × 1/8 in. steel angles, these being held to the beams by 3/32 in. countersunk iron rivets filed flush on the outside. The "dumb" buffers are further held to the beams by similar rivets, also flush on the outside. Note that 6 BA bolts are used to hold the front end of the frames to the buffer beam angles, but 4 BA are specified for those at the rear end, for essential extra strength.

When the frames and beams are finished, a trial assembly can be made, all the 4 and 6 BA bolts being put in and only done up finger-tight, while the assembly is placed on a surface plate, lathe bed, sheet of plate glass or what have you, and checked for truth, using feelers under the corners plus a try square. When all is satisfactory, the frames can be dismantled again ready for the fitting of the hornblocks and the bushes for the brake shaft.

This then is *Conway;* I hope she (it?) meets with readers' approval! *continued*

CONWAY

A free-lance narrow-gauge 0-4-0 saddle tank locomotive for 3½ in. gauge

by Martin Evans

Part II

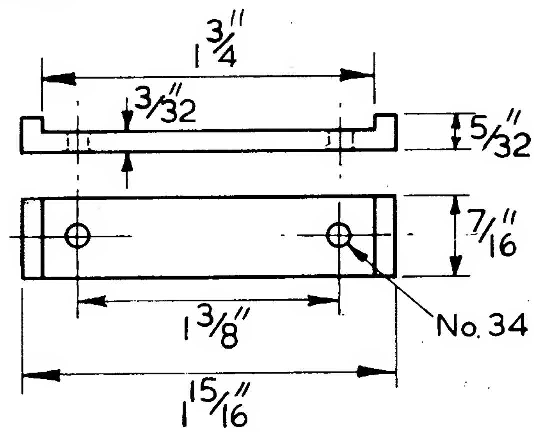
From Page 485

HAVING COMPLETED THE frames and buffer beams and fitted the corner angles, the next items to be made are the frame stretchers. The two outer ones made from ¾ in. × 1/8 in. steel angle also act as guards in event of a derailment, as mentioned in the last article. They are attached to the frames by short lengths of 5/16 in. angle, steel or brass. As far as I know, it is not possible to obtain steel angle in 1/16 in. thickness, but the ordinary 1/8 in. angle can be machined down very quickly by putting short lengths in the four-jaw chuck; machining away the unwanted 1/16 in. will at the same time ensure that the angle is really at 90 deg. Much of the commercial angle I have had recently was a good degree out of true.

The very simple round stretcher shown is machined from 3/8 in. diameter mild steel, with the ends tapped for 6 BA bolts. The stretcher just ahead of the firebox is cut from 1 in. × 1/8 in. flat steel and is held by 3/8 in. × 3/32 in. angles. Note that two "notches" will have to be filed in, to clear the flanges of the driving wheels. The only other frame stretcher required will be the motion plate, which will carry bushes for the valve rods and support an axle-driven pump, but this can be left for the moment, until we deal with the valve gear.

The hornblocks are of very simple shape, but considerably wider than usually specified for 3½ in. gauge locomotives. They may be in gunmetal or cast iron, the latter metal being longer lasting and of course quite a bit cheaper, though somewhat harder to machine. Note that they protrude right through the frames, being inserted from the inside, they should protrude 1/8 in. They can be machined by bolting them directly to the vertical-slide, which is set up facing the lathe spindle. A piece of steel bar across the face, plus a ¼ in. diameter Allen screw into a "T" nut in the slide will hold them firmly, while an end mill is worked all around, the saddle being locked to the bed and the cross-slide and vertical-slide traversed against the rotation of the end-mill. Another method, where a suitable machine vice is available which can be bolted firmly to the vertical-slide, is to clamp the horns directly in the machine vice for end milling.

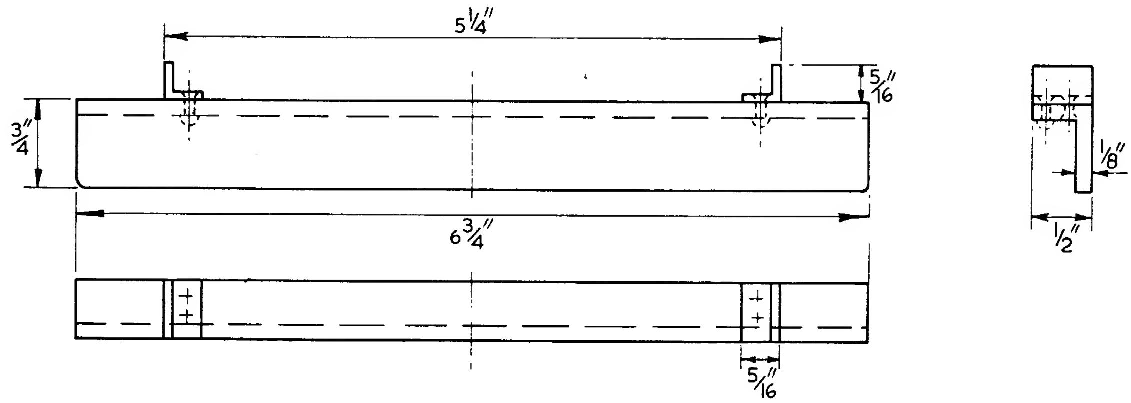
The hornstays are end-milled from ½ in. × 3/16 in. b.m.s. and are "stepped" so as to embrace the ends of the hornblocks. They are held to the underside of the hornblocks by 6 BA hex-head bolts. The axleboxes, of the split type, are machined from gunmetal castings, though if expense is a consideration, they could be made from mild steel and thin split bushes of gunmetal or phosphor-bronze used. Cast-iron would also be suitable.



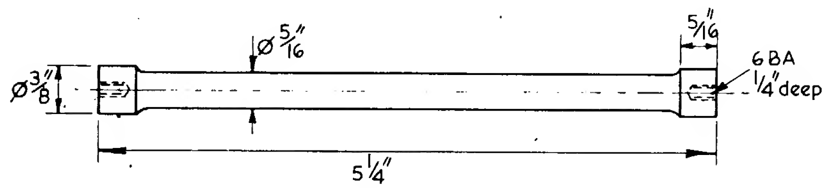
HORNSTAY

4 off b.m.s.

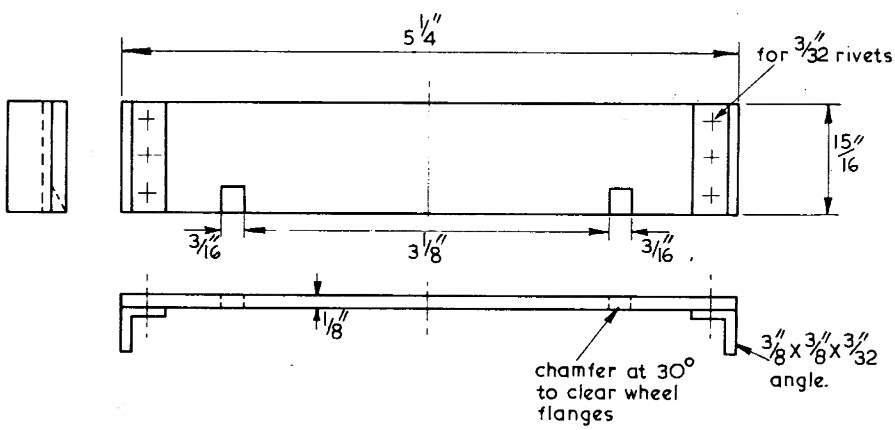
There are several methods for machining the axleboxes. The one I generally use involves machining the castings all around just deep enough to remove sand and scale and leave clean metal, then mark out the centre for the axle as accurately as possible, using square and scriber or odd-leg caliper, then set the axleboxes in the four-jaw, drill, bore and ream ½ in. diameter. Repeating for as many axleboxes as required, in our case, four. A very simple jig is next made, consisting of a length of steel about 1½ in. × 3/8 in. section, into which is pressed a short length of ½ in. diameter silver-steel, its upper end being drilled and tapped — say ¼ in. B.S.F. This jig is then set up in the lathe. It could be clamped down directly on the cross-slide using true pieces of packing to bring the axlebox, which is put over the pin and clamped by nut and washer, to lathe centre height. The working faces are then machined by end-mill in the chuck or collet. Another method, which is quicker, involves holding the jig on a piece of steel angle bolted to the vertical-



FRAME STRETCHER cum "SAFETY ANGLE"
2 off b.m.s.



ROUND FRAME STETCHER
1 off b.m.s.

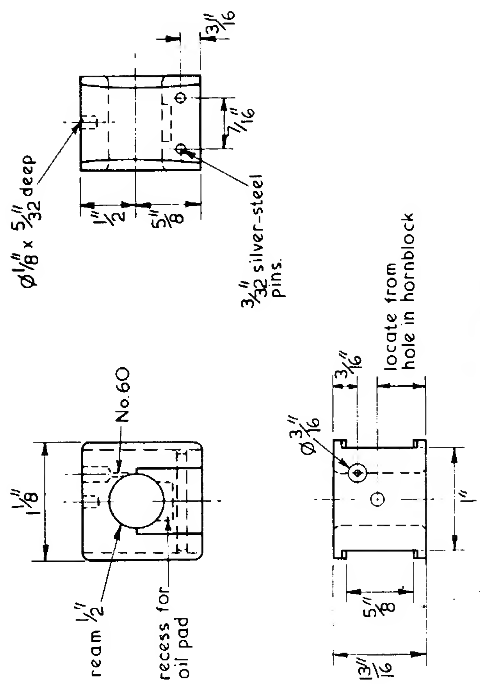


REAR FRAME STRETCHER: 1 off b.m.s.

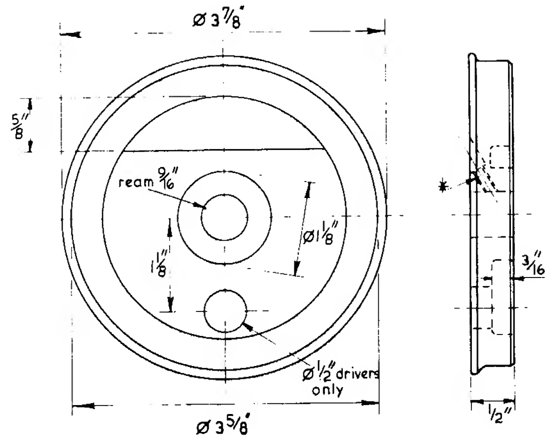
slide. This allows the axlebox to be raised and lowered so that an end-mill below 5/8 in. diameter can be used, without the necessity of altering the packing strips involved in the first method.

Where the axleboxes are of the split variety — as in our case — the "keep" of the axlebox has to be fitted before the box can be bored, so the first operation, after the "cleaning-up" cuts, would be to machine the slot for the keep. This could be 9/16 in. wide. The keep can be soft soldered in position ready for the boring and reaming operations. After finishing the axleboxes to size, the keeps are melted out and fitted in place permanently by using two silver-steel pins, 3/32 in. diameter, slightly shorter than the width across the working faces of the axlebox and with their ends well rounded.

Tackle the wheels next. They are simple disc type, in cast-iron, and will probably have the balance weights cast in. To assist in balancing, a ½ in. diameter hole can be drilled *in the driving wheels only,* at 1 1/8 in.

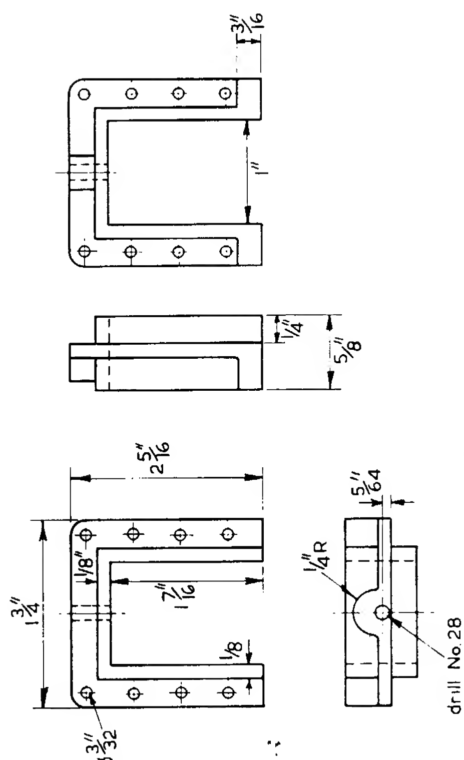


AXLEBOX: gunmetal 4 off



DISC WHEEL: 4 off cast-iron

* Optional—tap 4 BA for socket-head grub screw (press fitted wheels only)



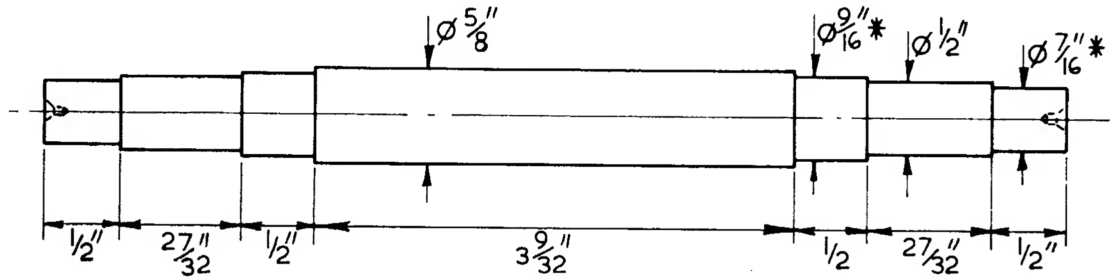
HORNBLOCK: cast iron or gunmetal 4 off

from the centre. The wheels have been made somewhat wider than is normal for 3½ in. gauge locomotives, which is usual practice for narrow-gauge engines. The flanges should of course be well radiused into the treads.

The axles are best turned completely between centres, from the nearest larger mild steel available. At this point, builders will have to decide whether to press fit their wheels and outside cranks, or to use Loctite. For the former, the wheel seats and the outer ends of the axles on which the outside cranks are mounted should be very carefully turned to a good one thou. larger than the nominal bore of wheels and cranks. My advice to beginners here would be to first turn up a short stub of steel to this size and try in wheel or crank, as the case may be, but don't of course press the stub too far in, or it may be difficult to get out again. Furthermore, it might have the effect of very slightly enlarging the bore, especially of the cranks, being of mild steel, as against cast-iron in the case of the wheel!

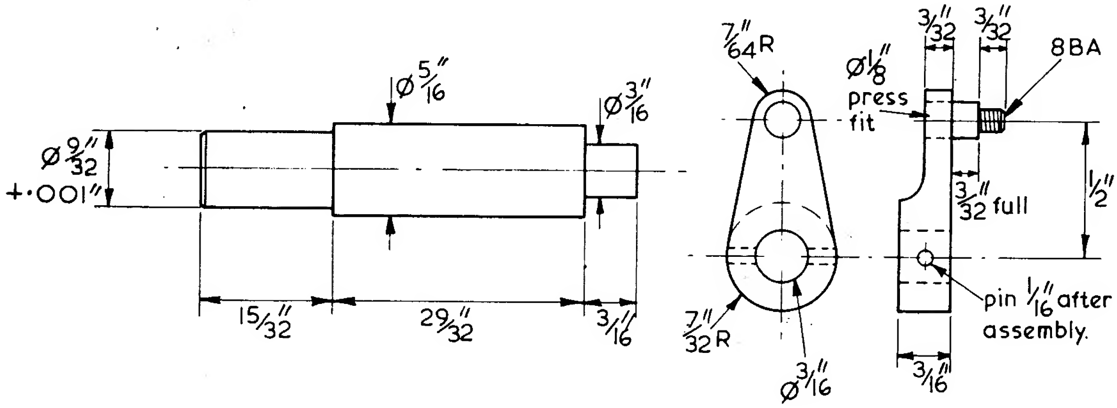
It is not possible to pin the wheels on their axles in the way we generally do in gauges 2½ in. to 5 in. as we cannot of course gain access to the front of the wheel, once it is on the axle. A Woodruff key could be used, but an easier method is to fit a 4 BA Allen socket-head grub screw at an angle, as shown, starting the tapping drill for this by an end-mill. The grub screw can be twisted in firmly until it cuts into the (softer) metal of the axle. However, I should emphasise that this method is not nearly so strong as a proper key. Personally, I would dispense with pins or keys altogether and use Loctite high-strength. No. 35 is the one, though this has now been re-numbered to 601. If Loctite is used, the grub screw suggestion should not be adopted, owing to the probability of distortion.

The outside cranks are made from b.m.s. 1 in. × ½ in. As it is most important that all four are made to exactly the same throw, I would suggest the following

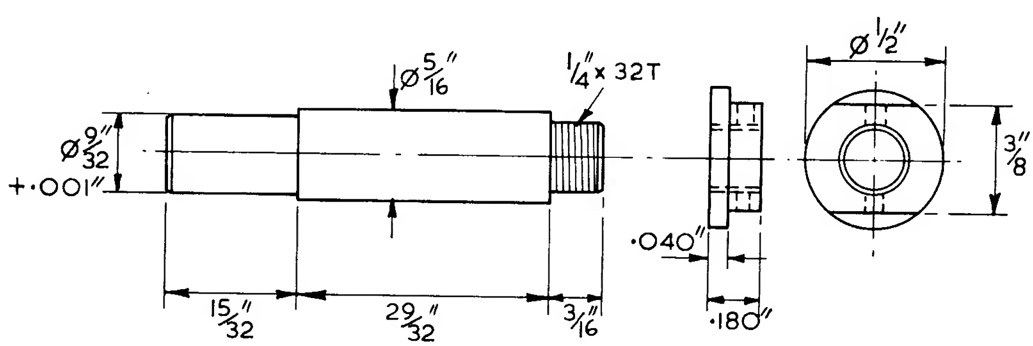


AXLE: 2 off b.m.s.

* +·001″ for press fit
— ·001″ for Loctite



RIGHT–HAND DRIVING CRANKPIN & CRANK TO DRIVE MECHANICAL LUBRICATOR. 1 off silver–steel



LEFT HAND DRIVING CRANKPIN 1 off silver steel
and retaining collar

procedure:- Cut the blanks somewhat oversize as to length and mount each one on a small angle-plate bolted to the faceplate. Centre, drill and bore to the required finished (axle) size. Now make a simple fixture, again a short length of b.m.s. bar on which is set out the required throw as accurately as possible. At one point drill and ream a hole 5/16 in. diameter. At the other fit a silver-steel pin turned to an exact fit for the embryo cranks. Put the fixture on the faceplate, clamp up lightly and shift about until the 5/16 in. hole is dead true at lathe centre (to do this, slip a short stub of 5/16 in. silver-steel into the hole and use a D.T.I.) Clamp firmly. Now all we need to do is to insert each embryo crank in turn on the fixture, lining up the second (crankpin) location by using the lathe tailstock centre, then clamp, when drilling, boring and reaming for the crankpin can proceed. Note that a balance weight of some kind will be needed on the faceplate, especially when the cranks are put on. The crankpins are straightforward turning jobs in 5/16 in. diameter silver-steel, but note that the driving crankpins differ from left to right, as the intention is to mount a short ½ in. throw crank on the right-hand one to drive the mechanical lubricator, which will be situated in the cab.

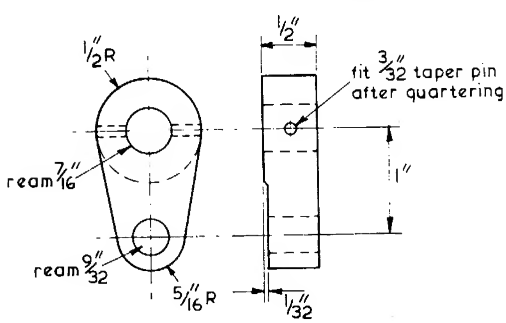
Any builder who prefers to put the lubricator in front of the smokebox between the frames will not need this little crank of course.

WARNING: Don't put the wheels or cranks on their axles just yet as there are five eccentrics to go on between the wheels, not to mention the "quartering" of the cranks!

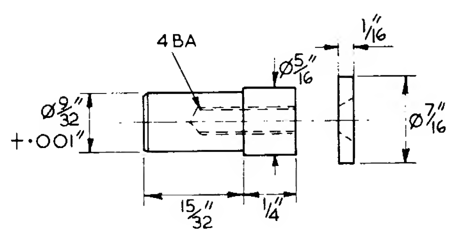
Coupling rods

I am showing plain un-fluted coupling rods, but they are "fish-bellied" as on many full-size narrow-gauge engines. However, straight rods may be fitted for those who want to get the locomotive on the rails as quickly as possible. Material is 1 in. × ¼ in. b.m.s. The bearing holes can be located at the correct spacing by using a trammel, but drill them ¼ in. diameter at first, then transfer to a length of stout steel angle bolted to the vertical-slide. Bolt the coupling rod blanks down on this having previously set it exactly level, then each side of the rod can be milled down by 1/32 in. using an end-mill about ½ in. diameter. The ends of the rods can be filed to shape, or the old dodge used for rounding the ends up to the oilboxes by mounting the rods on a stub of square brass turned to ¼ in. diameter at one end and clamping same under the lathe toolholder. The rods are then swung against a small diameter end-mill held in the chuck. Care must be taken here, to ensure that the rod is only turned against the rotation of the end-mill.

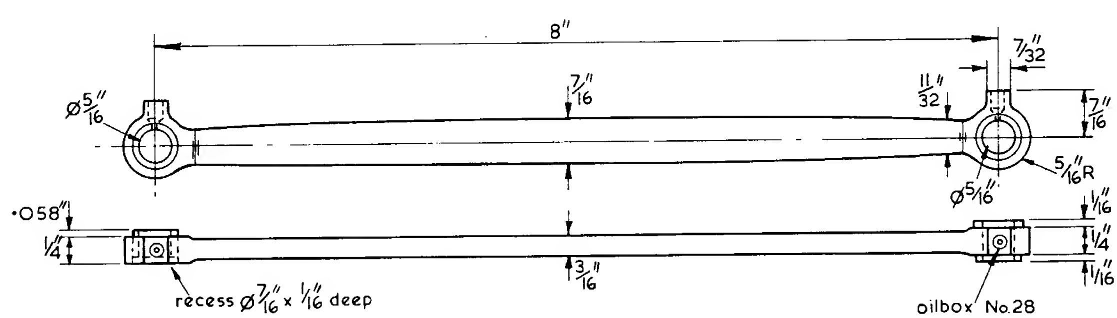
The bushes can be turned from cast phosphor-bronze, but don't make them just yet, as we need to use the partly made coupling rods to "quarter" the cranks and this cannot be done until the eccentrics have been made, as I mentioned earlier. *Continued*



OUTSIDE CRANKS: 4 off b.m.s



LEADING CRANKPIN 2 off silver-steel
and retaining washer



COUPLING RODS: L.H. drawn b.m.s.
Bushes cast gunmetal

CONWAY

A free-lance narrow-gauge 0-4-0 saddle tank locomotive for 3½ in. gauge

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Part III

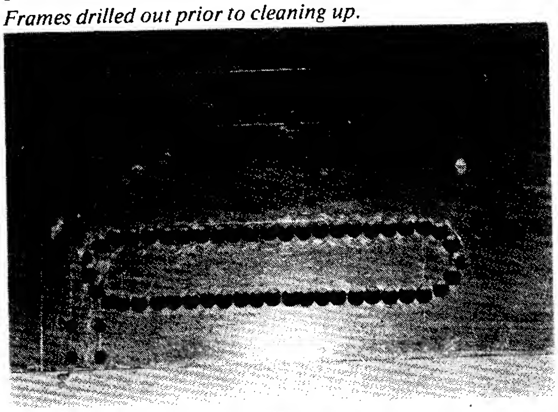
WE CANNOT ASSEMBLE the driving axle, with its axleboxes, wheels etc, until we have made and fitted the eccentrics, so these may be tackled next. They can be made from cast-iron or mild steel. If the latter, sufficient for the five eccentrics should be cut off from 1½ in. dia. bright steel bar, this being turned down to 1 13/32 in. dia., and then the working surfaces to 1 9/32 in. dia., allowing a little extra width on both sides of each eccentric for final cleaning up. I find the best tool for this job is a parting tool with the cutting face ground off quite square, but with just the sharp corners removed with a stone. If the lathe is run at a moderate speed and plenty of cutting oil used (only for steel eccentrics of course) there should be no difficulty in obtaining a nice smooth surface.

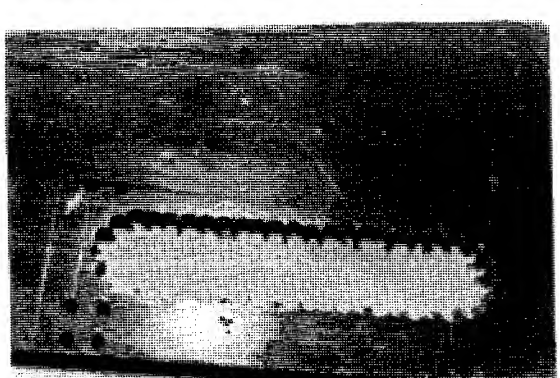
After parting off the five eccentric blanks, their centres will be indicated by the turning marks, so the ¼ in. throw can be marked off with dividers. No very great accuracy is required here, so long as all four of the valve gear eccentrics have exactly the same throw. If anything, err on the large size, as there is generally a tiny amount of lost motion in even the best made valve gear.

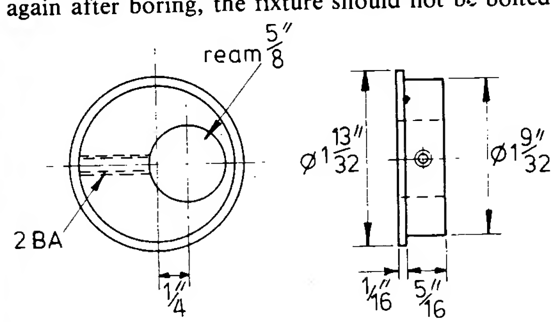
The four-jaw chuck can be used for holding the eccentrics for boring, but as the jaws would mark and spoil the rather thin flanges, a brass split ring should be turned up to hold them. This ring could be made from a short piece of thick-walled brass tube, or from a brass blank. It is set up in the three-jaw, and turned and bored an exact fit for the valve gear eccentrics (the pump eccentric, being double-flanged, will have to be treated separately) and to a length of 5/16 in. A fine saw cut is then made, after which it is set up in the four-jaw and the jaws adjusted until the new axle centre is running truly. Slightly release jaws No. 1 and 2, then tighten down again, to hold the eccentric firmly; if the other three eccentrics are put in without moving jaws No. 3 and 4, and the same force used on the chuck key each time, there should be very little variation in the throw of the eccentrics — that is, providing the four-jaw chuck is in good shape.

A more accurate way is to use a fixture bolted to the lathe faceplate. A rectangular piece of metal — mild steel, gunmetal or brass — of 5/16 in. thickness is bolted to the faceplate and bored out a good fit for the eccentrics. We now need something to hold them firmly for boring. So drill and tap 2 BA from the side of the fixture at an angle to the vertical, so that a screw (socket-head grub screw) will have a wedging action on the eccentrics when they are placed in the recess. Interpose a short piece of copper rod between screw and eccentric so that the latter does not become scored. To ensure that the eccentric can be got out again after boring, the fixture should not be bolted

Frames drilled out prior to cleaning up.

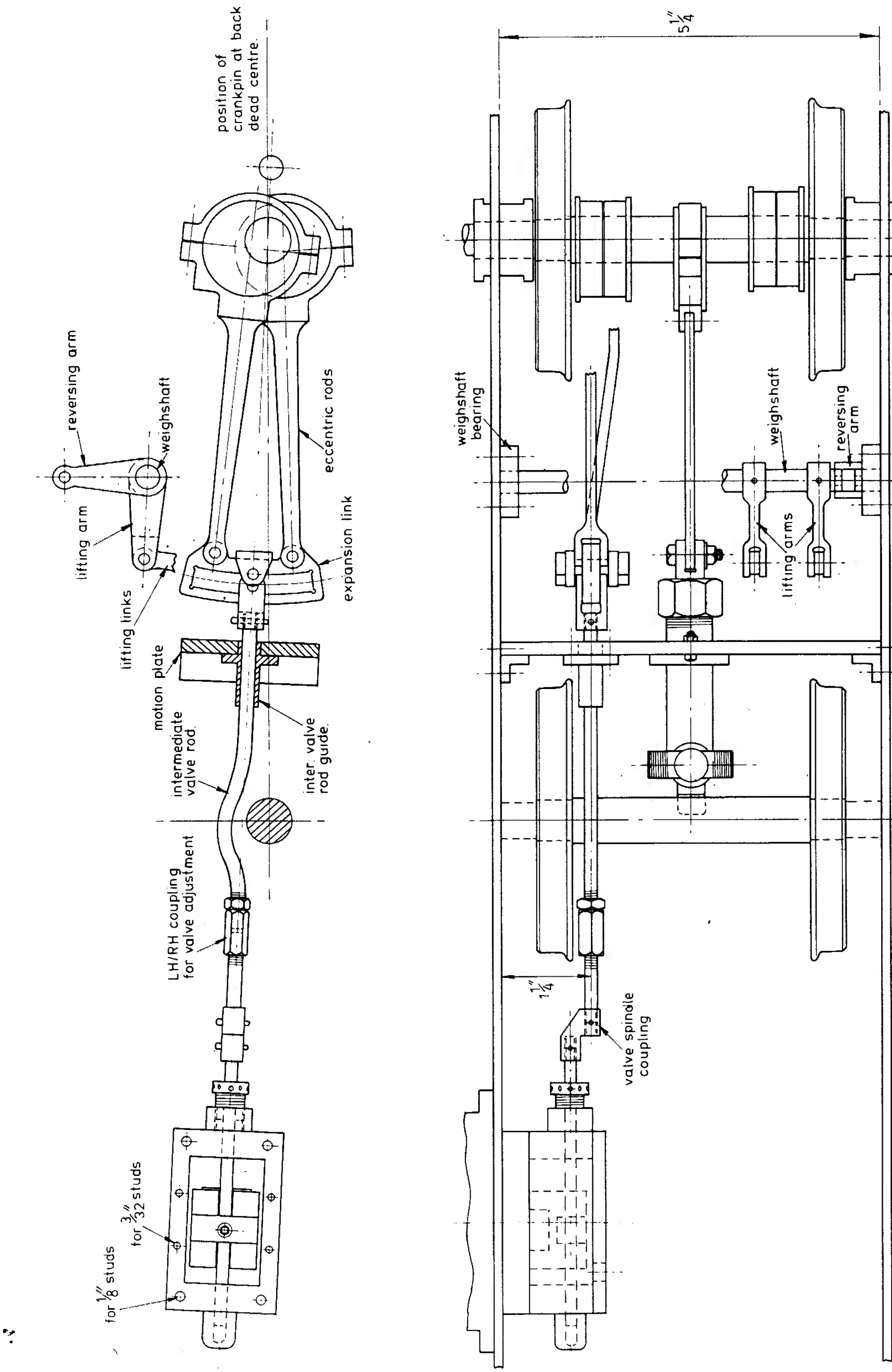




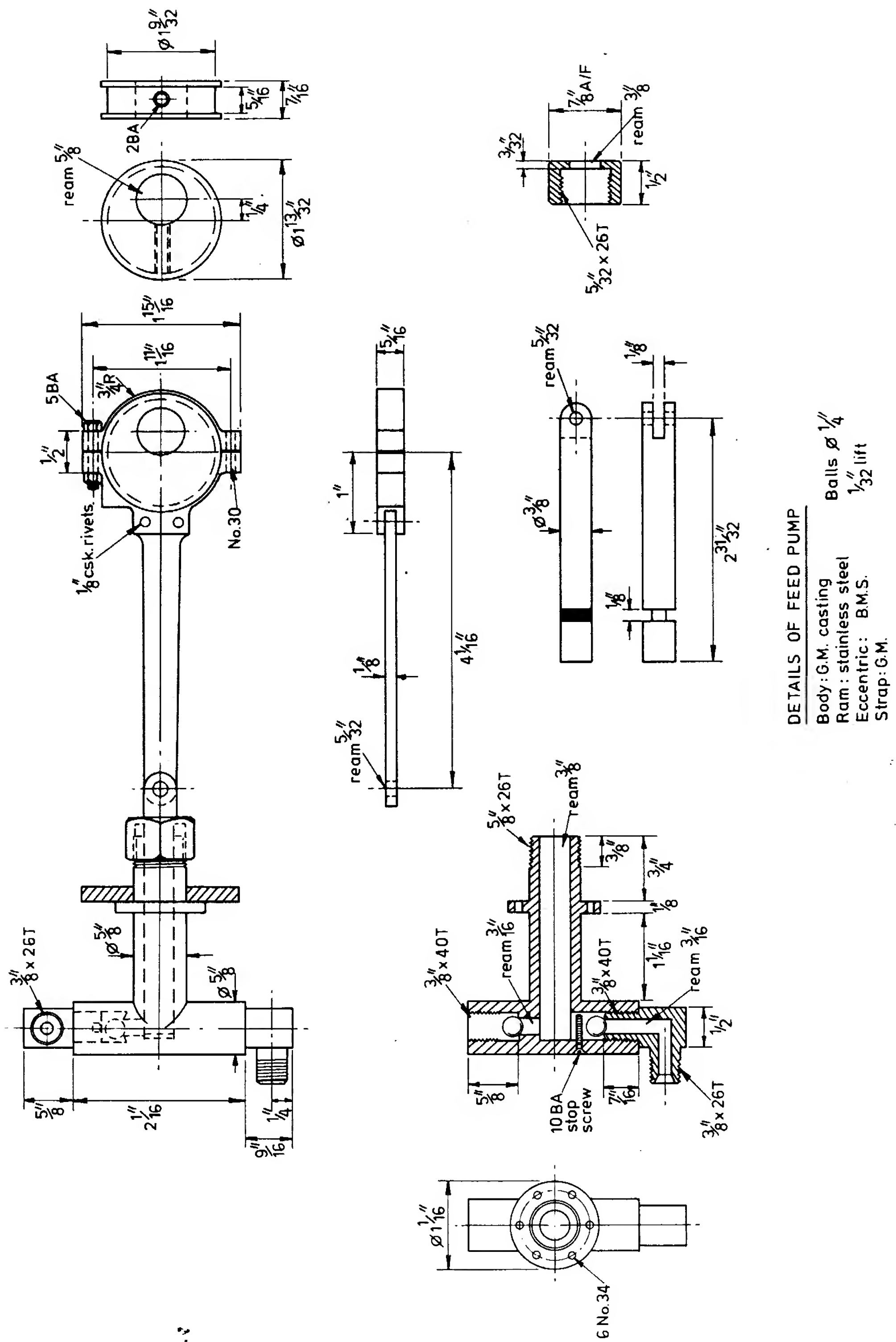


ECCENTRICS for VALVE GEAR

4 off cast-iron or B.M.S.



LAYOUT OF VALVE GEAR & FEED PUMP



DETAILS OF FEED PUMP

Body: G.M. casting
Ram: stainless steel
Eccentric: B.M.S.
Strap: G.M.

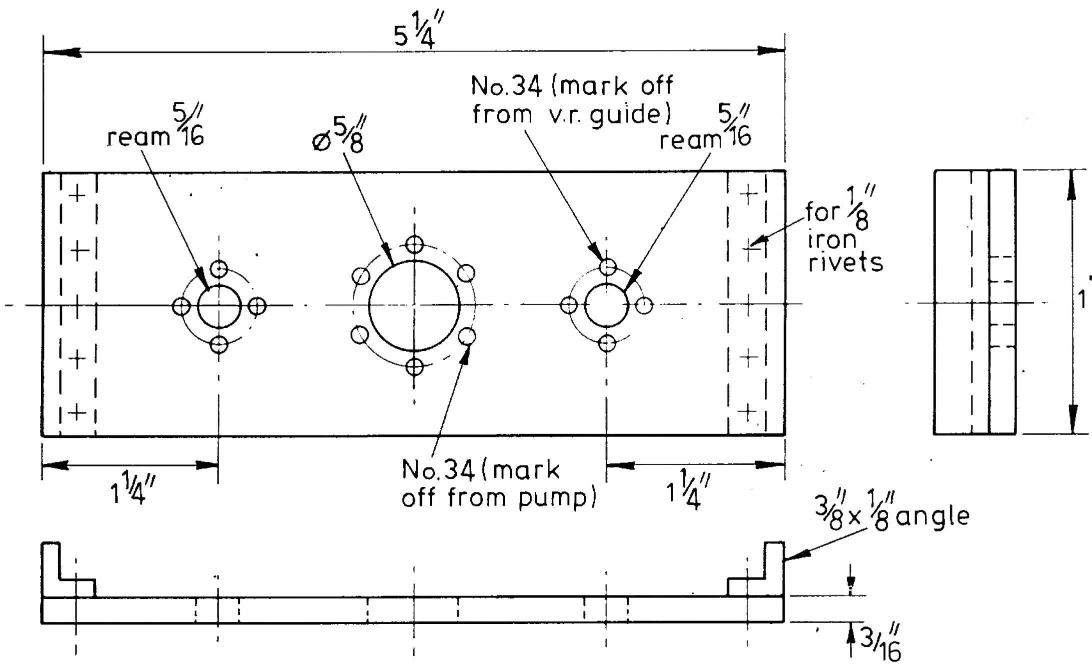
Balls ø 1/4
1/32" lift

directly against the faceplate, but two true packing strips should be arranged between the two. This will also permit the boring tool to pass right through the eccentric without fouling the faceplate. The centre of the fixture is now shifted to a full ¼ in. from lathe centre and bolted firmly, ready for boring. If a 5/8 in. reamer is available, boring should be continued until only 3 or 4 thou. are left for it to remove, as it is important that the eccentrics should be a really close fit on the driving axle.

To finish the eccentrics, they can be mounted on a short stub of the same 5/8 in. bar used for the axles, and held by their own (socket-head) grub screw. A light skim is then taken off from each side to bring the eccentrics to the required width.

elaborate method of fixing would have been necessary. As can be seen, the pump ram works right through, between the inlet and outlet ball valves, which I think is much preferable to the so-called "anti-airlock" pin so often seen. While it would have been comparatively easy to bore and ream for the ram right through the casting, fitting a bolt-on cover plate on the outside, it should not be too difficult to finish a "blind" bore if, after reaming, a D-bit is used to open out the extreme end, left undersize by the "lead" of the reamer. The valve chambers use ¼ in. diameter balls on 3/16 in. diameter reamed seatings, the lower ball being fitted with a stop screw, 10 BA brass, to limit ball rise to about 1/32 in.

The motion plate could be made next, from 3/16 in.



MOTION PLATE: B.M.S.

Feed pump

The feed pump is of very simple design, machined from a gunmetal casting. I should emphasise that the 3/8 in. bore specified, while sufficient for an engine that is likely to do all its work on continuous tracks, is unlikely to be adequate for use on an "up-and-down" track, in which case I would suggest opening out the bore to 7/16 in.

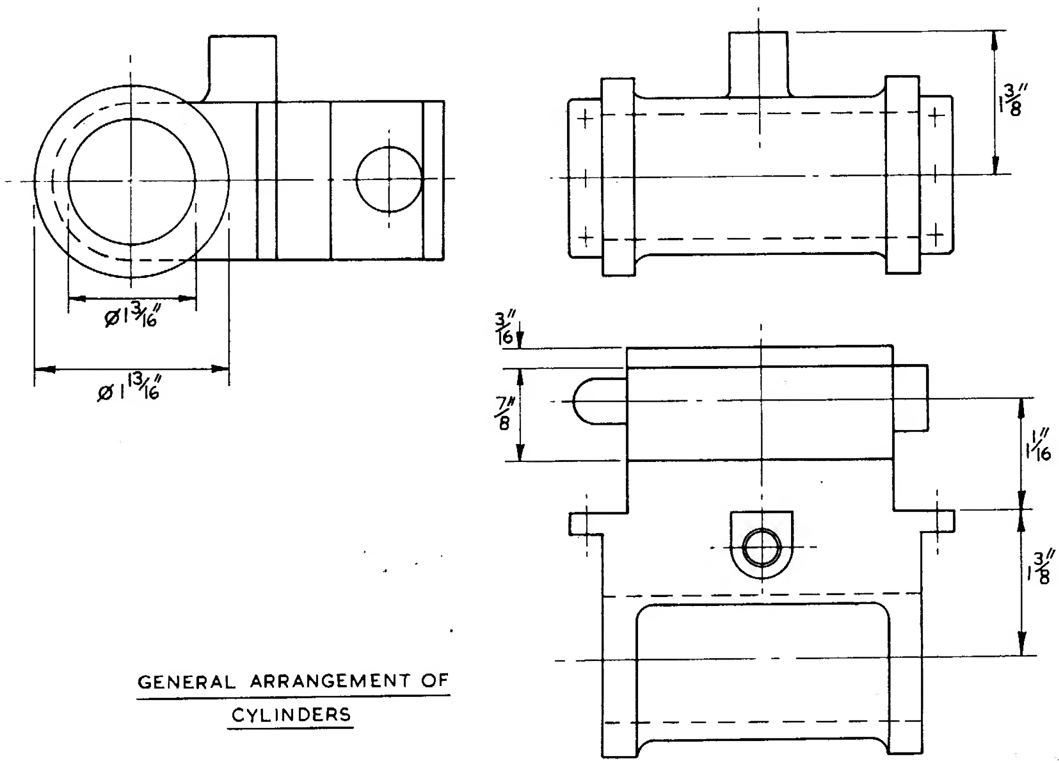
It may be asked why the bolting flange, by which the pump is attached to the motion plate, is shown on the valve-box side of the motion plate, resulting in the working stresses coming directly on the fixing screws. But had the flange been placed on the other side of the motion plate, it would not have been possible to cast it integral with the body of the pump, and some more

steel plate. It is held to the frames by 3/8 in. × 3/8 in. × 1/8 in. steel angles. Before fitting it to the frames, the feed pump could be bolted to it, and the two intermediate valve rod guides made up and fitted. I expect that gunmetal castings will be available for these valve guides, otherwise they could be turned from 13/16 in. diameter or nearest larger phosphor-bronze. They are reamed right through 3/16 in. diameter and bolted to the motion plate with 6 BA hex-head bolts, as shown.

Cylinders

Either gunmetal or cast-iron cylinders can be used; perhaps with the comparatively small ports and long steam passages unavoidable in this type of cylinder, gunmetal will be preferred by most builders.

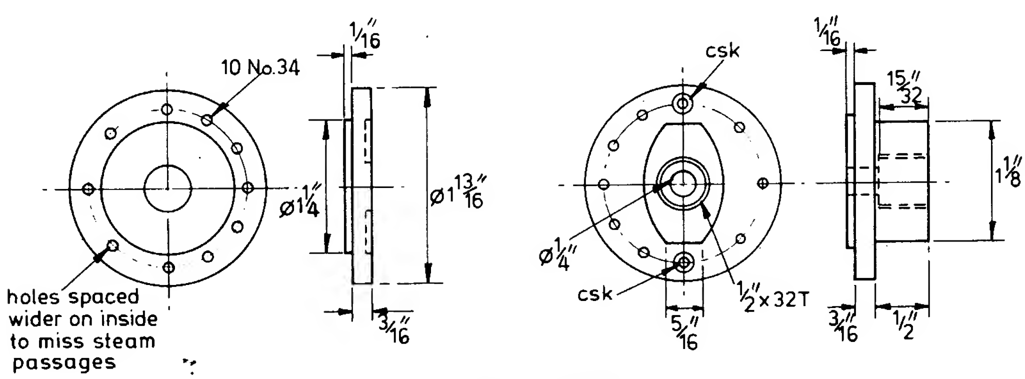
While the cylinder blocks could be bored and faced



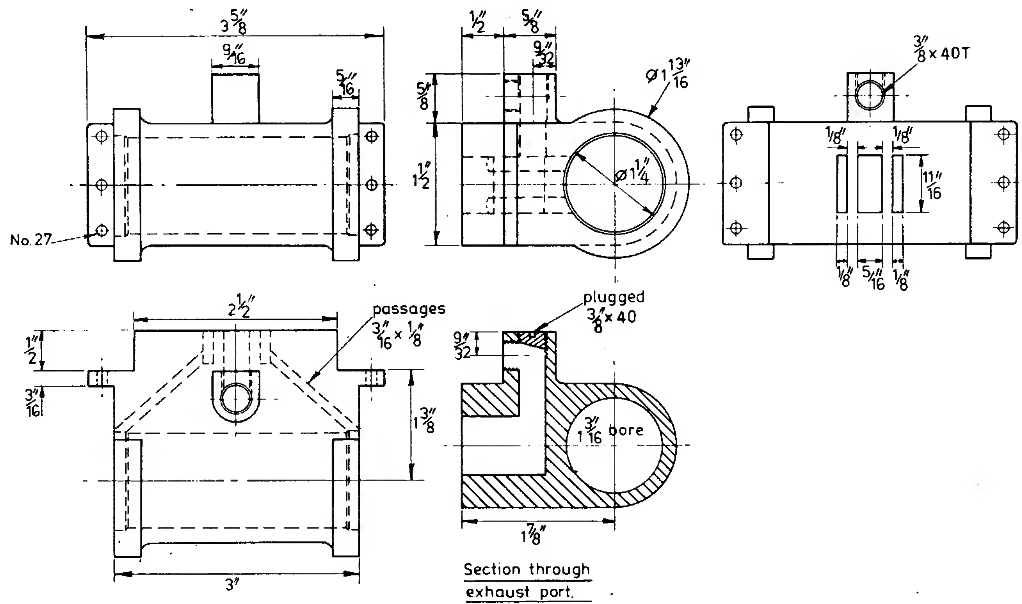
GENERAL ARRANGEMENT OF CYLINDERS

on an angle plate bolted to the faceplate, as they are on the long side I think a better way is to bolt them down on the cross-slide and use a between-centres boring bar. But first the ends of the blocks can be rough filed, and the port face machined using the four-jaw, so that a true surface is obtained to register against the cross-slide. One end of the block is then machined by fly-cutter, after which boring is carried out, using the self-act. There is no need to ream the bores, a good finish can be obtained if the boring tool is carefully re-sharpened and stoned just before the final cut, and the final cut repeated a second time without shifting the tool-bit in case of any slight spring in the tool.

It is well worth cutting a recess, at 1 ¼ in. diameter, at each end of the bores, into which the covers are fitted, as this makes it easier to drill the steam passages to the ports, and also easier to fit the packing (or rings in the case of a cast-iron cylinder). This must of course be done without the self-act, feeding the block carefully by hand.



FRONT & REAR COVERS



CYLINDER DETAILS

To machine the other end of the blocks, the usual method of turning up a length of brass or light-alloy rod a close fit in the bore can be used, though it would not be impossible to fly-cut this on the cross-slide if the block is reversed and carefully lined up.

The four covers can be tackled next, holding them by their chucking spigots and turning the bore registers first, then using a chucking ring to hold them for turning the other side. The rear covers must be accurately centred, drilled and reamed at the first operation to ensure that the piston rod will be concentric to the bore, though it is not a bad plan to open out the bores of the rear covers *after* the crossheads and slide bars have been fitted and lined up, which may well save a little unnecessary friction here. The odd spacing of the fixing holes in the covers avoids any danger of running into the steam passages.

The bolting flanges can be end milled at the same set-up as used for cutting the steam and exhaust ports. The vertical-slide is set up facing the lathe headstock, and a stout angle-plate is bolted to it and set exactly horizontal. The cylinder block can then be bolted to the angleplate with the bore vertical, using a long bolt or length of screwed rod plus a large washer made of brass or copper. The port face and bolting flanges are arranged to overhang the edges of the angle-plate sufficiently to allow the end-mill to do its work. An end-mill of 3/8 in. or ½ in. diameter will do the flanges, while a 3/32 in. diameter slot drill can be used for the steam ports, followed by one of 1/8 in. diameter. (If one of 1/8 in. diameter is used first, the port cut will almost certainly come out somewhat over-size). Assuming gunmetal cylinders, the end-mills should be run at top speed, and the cut applied very gently indeed, not more than 8 thou at a time. If the cylinders should be in iron, the lowest "direct-drive" speed should be used.

In my next article on *Conway*, I will deal with various ways of cutting the steam passages between ports and bores. *Continued*

THAT *ENTERPRISE* SADDLE! — Several readers have pointed out a draughtsman's mistake in the drawing of the saddle for *Enterprise* page 421. A bold line was omitted on each side where the notes about clearance for the exhaust pipes were situated, so that, as drawn, the saddle would appear to be in two parts! In fact, there should be 3/16 in. thickness of metal all around the saddle.

A further point. To make for easier pattern-making and moulding, the projection along the sides of the saddle which would normally rest on the top edge of the frames will be omitted from the casting. A strip of mild steel of (say) ¼ in. × 1/8 in. section may, however, be attached to each side, by rivets or screws, after machining the sides. Although not essential, this strip does allow the weight of the front end of the boiler, plus the smokebox, to bear directly on the frames, relieving the screws in the corners of this weight.

CONWAY

A free-lance narrow-gauge 0-4-0 saddle tank locomotive for 3½ in. gauge

by Martin Evans

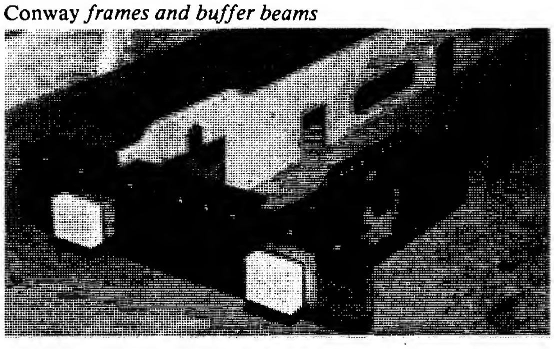
Part IV

From Page 737

THE NEXT JOB on the cylinders is cutting the steam passages between the ports and the bores. As these passages are unavoidably long in this type of cylinder, I think it is essential to use the drilling machine, rather than trying to drill by hand. The passages are too long to be endmilled out and, to obtain the desired area, we could adopt a method suggested by the late Jim Crebbin—drill one hole, 1/8 in. dia., then plug this lightly with a length of brass rod. This rod must be an easy fit; tack it in position with a little soft solder, mark out for the second 1/8 in. dia. hole, drill this, then melt out the brass rod. The resulting hole can be cleaned up by a small coarse-cut round needle file, though this it not essential. Next, drill the hole for the exhaust outlet—11/32 in. dia., tapping it 3/8 in. × 40T., then drill vertically, again 11/32 in. dia., straight down into the exhaust port, as shown in the cross-section. Tap this hole 3/8 in. × 40T. about 1/4 in. deep and make up a threaded plug—very slightly tapered, to match. This can be filed off at an angle to improve the path of the steam, though again this is only a minor point. This plug can be given a taste of plumber's jointing, as it will not have to come out again.

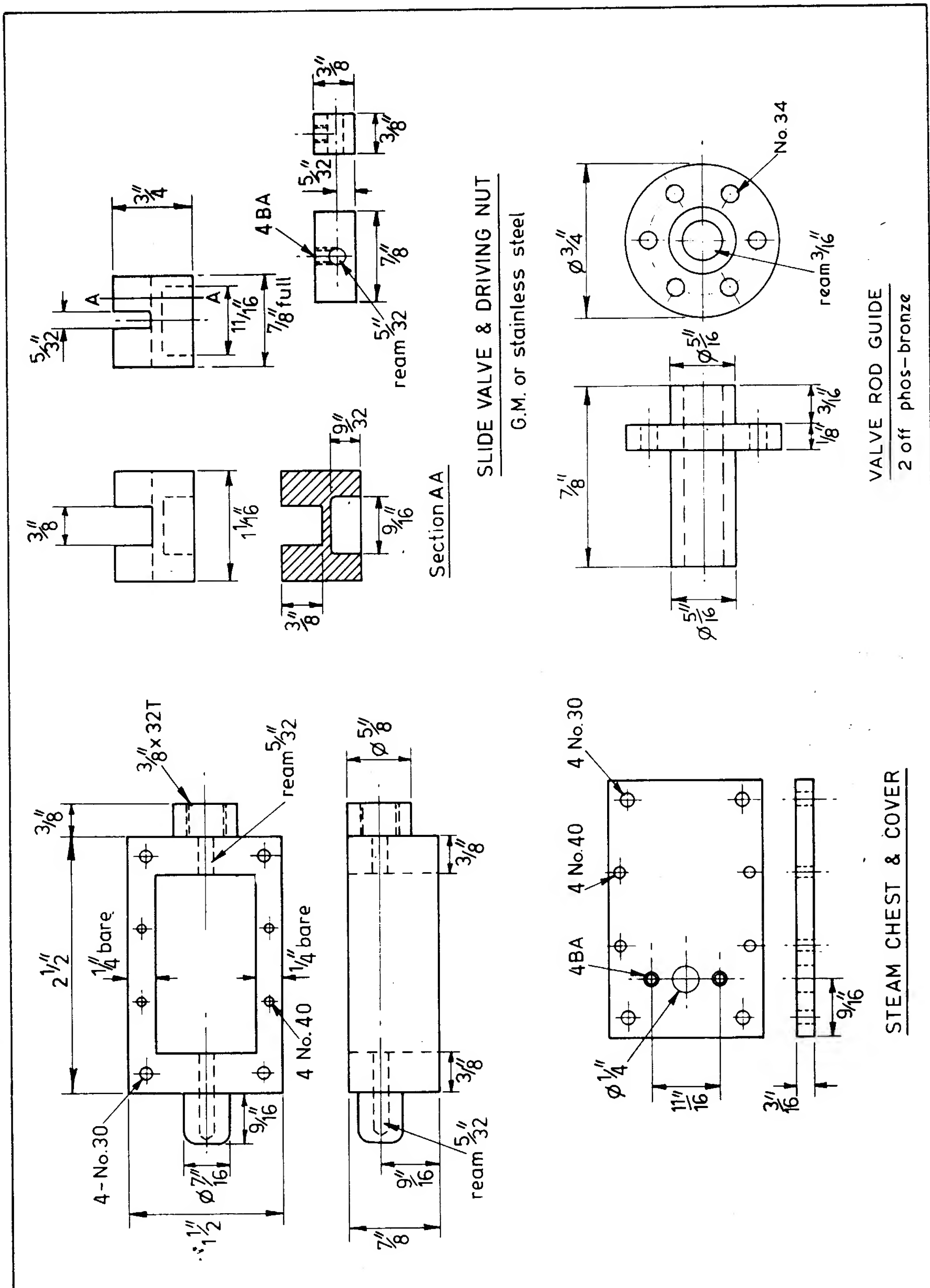
The steam chest comes next. All faces of this can be machined using the four-jaw chuck. The front and rear bosses should both be machined, the front boss being dealt with first, then the rear boss can be drilled, reamed and opened out for the gland at the same setting. To drill and ream the front boss, the 5/32 in. dia. drill can be used, being passed right through the rear boss to make a deep centre on the other side of the casting, but before doing this, the inside should be filed to size and as true as possible, otherwise the drill is certain to wander. Check the position of the centre before drilling No. 23 and reaming, as it is still possible to draw the hole over if it is out of line. Another method, which I generally use myself, is to drill the front boss from the outside, using a drill somewhat smaller to start with, then open out to size from the rear end. The front boss is then securely plugged, as this has of course to be steam-tight.

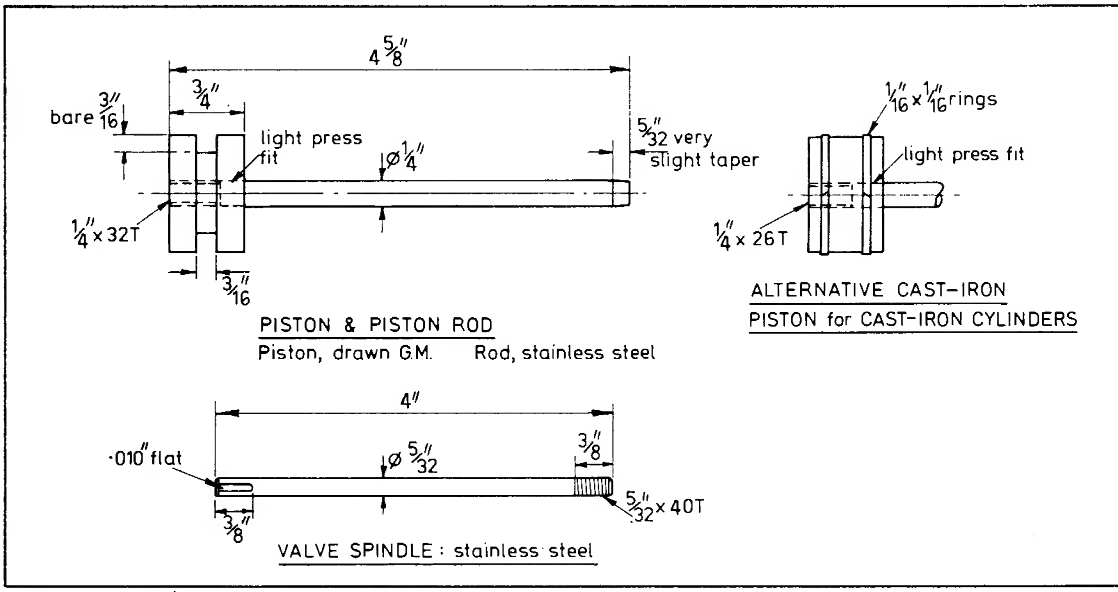
Conway *frames and buffer beams*



The steam chest covers may be gunmetal castings, or 3/16 in. hard brass sheet may be used. The holes for the fixing studs can be drilled in the covers, which are then used as drilling jigs for the steam chests and blocks, using the tapping size drills,—the studs are partly 3/32 in. dia. threaded 7 BA and partly 1/8 in. dia. threaded 5 BA. I suggest No. 47 drill for the 7 BA's and No. 39 or 38 for the 5 BA's, the steam chest and covers being opened out after tapping the blocks.

The pistons and piston rods come next. Drawn gunmetal or phosphor-bronze for the former, and although the usual graphited yarn can be used for packing, it is worth while trying proper rings if these are also in phosphor-bronze. Two rings of 1/16 in. × 1/16 in. section would be about right. With this size of piston, it is a bit unwise to rely on the grip of the tailstock chuck to get the rod right home in the piston, so make the rods first, putting a very slight taper on the crosshead end with a dead-smooth flat file, then turn the piston blanks, leaving them a few thou over-size, drill and tap 1/4 in. × 32T. (× 26T. for cast-iron pistons) then open out with letter D drill for about 1/4 in. depth. The piston rod can then be held in the tailstock chuck and partly screwed into the piston by pulling the lathe belt by hand; then transfer to the bench vice, clamping the piston rod firmly in the vice (between soft metal jaws) when the piston can be screwed right home by gripping in the hands. If the 3-jaw does not grip 1/4 in. dia. really truly, a collet must be used for finishing the piston, or a split-bush if no proper collet is available. Only the very lightest cuts

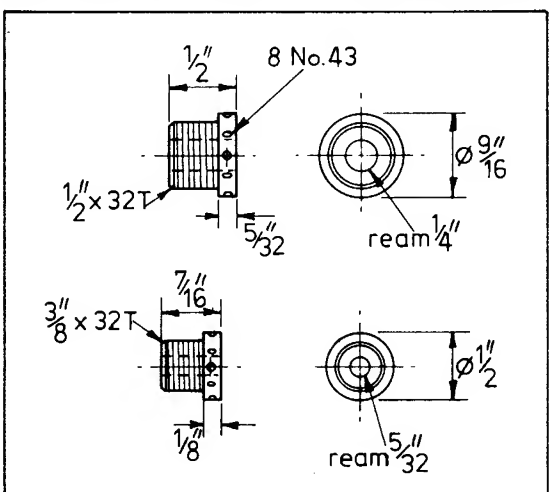

SLIDE VALVE & DRIVING NUT
G.M. or stainless steel
Section AA
VALVE ROD GUIDE
2 off phos-bronze
STEAM CHEST & COVER
4BA
No. 34
4 No.30
4 No.40
4-No.30
4 No. 40
3/8" x 32T
5/32" ream
3/16" ream
1/4" bare
7/8" full



with a really sharp tool should be used for the final finishing of the pistons, which must be a good fit without packing if they are to remain steam-tight, but not "mechanically" tight.

Slide valves

The slide valves could be made in one of three different ways—from a gunmetal casting, from drawn bronze bar, or built up with a top half of bronze and bottom half of stainless steel, the two parts being brazed together. If the last mentioned method is used, the lower part should be 9/32 in. thick, so that the "cavity" can be filed out. For either of the first two methods, the cavity is best cut out first using a slot-drill of about 1/8 in. dia., the rounded corners will be no disadvantage. The vertical-slide can be used here, with slot-drill in the chuck or collet. The slot for the driving nut is best cut in two passes. If a 3/8 in. dia. cutter is used, the slot will almost certainly be too wide for a piece of 3/8 in. bar to be used for the nut and we don't want any slackness here. Equally important, the nut must be quite free in the slot, or the pressure of the steam may not be sufficient to ensure the valve being held against the port face. Incidentally, it is most important to ensure that the valve can be lifted very slightly off the port face when the cylinders are finally assembled, otherwise there could be a leak of steam direct to exhaust. To complete the cylinders, we require the valve spindles—from 5/32 in. dia. stainless steel and the piston and valve rod glands, which are best screw-cut in the lathe to ensure concentricity.



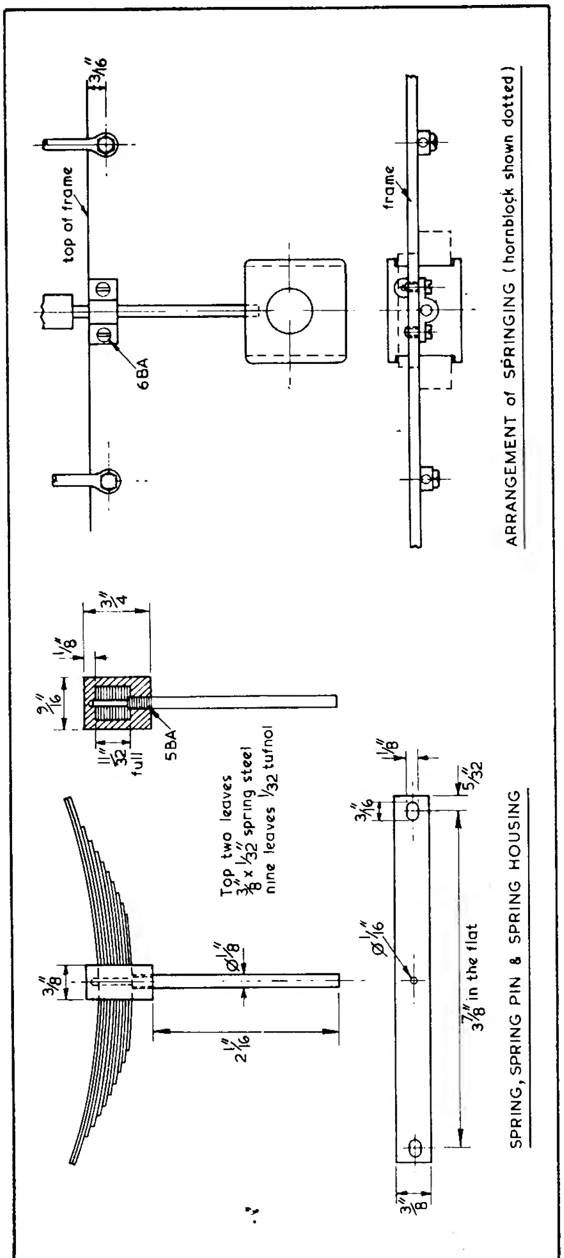
GLAND NUTS for PISTON ROD & VALVE SPINDLE

Axlebox springing

I think readers will agree that an engine of Conway's type should have proper leaf springs, which are such a characteristic feature of many narrow-gauge engines. The problem with leaf springs, however, is to get them light enough while at the same time sufficiently "deep" to look right. It might be possible to use spring steel throughout, but this would mean slotting out almost every leaf except the top one until not much of each was left! So I think the only practical answer is to make most of the leaves from Tufnol.

The Tufnol will have to be coaxed into quite a small radius before assembly, which means that it will have to be heat-treated. One way of doing this is to obtain a circular tin—a tobacco tin is ideal—into which strips of Tufnol can be arranged, enough for one spring at a time. The tin is then put on the hot-plate of the cooker and the temperature slowly raised until just below the

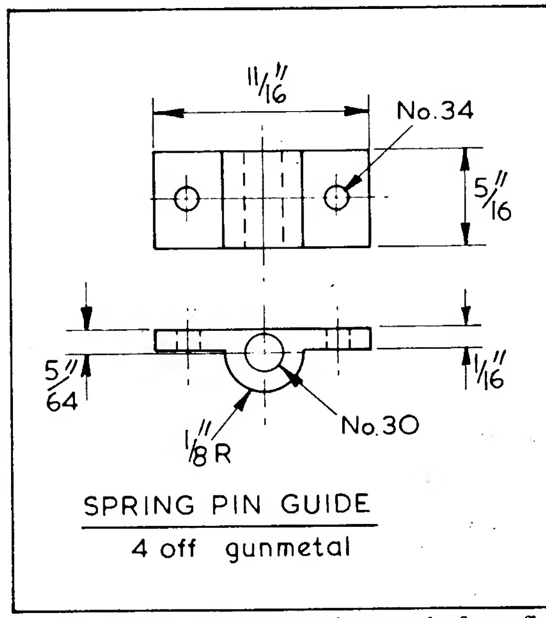
point where the Tufnol starts to blister. The right point can be found by first experimenting with a sample strip. If the temperature is too high and the Tufnol is blistered, it will be found too brittle for the job. The spring steel leaves can be bent by hand. The spring housings are made from 5/8 in. × 3/8 in. mild steel, this being first milled or filed down to 9/16 in. wide. They are then drilled and filed out to a close fit for the bunch of leaves, the spring pins—made from 1/8 in. dia. silver-steel—clamping them firmly in place.



ARRANGEMENT of SPRINGING (hornblock shown dotted)

SPRING, SPRING PIN & SPRING HOUSING

To make the spring hangers, chuck 1/4 in. × 1/8 in. mild steel strip in the 4-jaw and set to run truly. Allow a bit extra at the outer end and put a small centre in the end, so that tailstock support can be given, while the major part of the strip is turned circular. But as it is very difficult to turn flat strip of 1/8 in. thickness to 1/8 in. diameter, adopt the old dodge of heating it to redness and giving the part to be turned circular a good squeeze in the bench vice. After turning to size, carefully saw off the excess, chamfer, and thread the end 5 BA for a length of 3/16 in. To complete the spring hangers, drill the "eye" ends 5/32 in. dia. and radius by filing or end-milling.



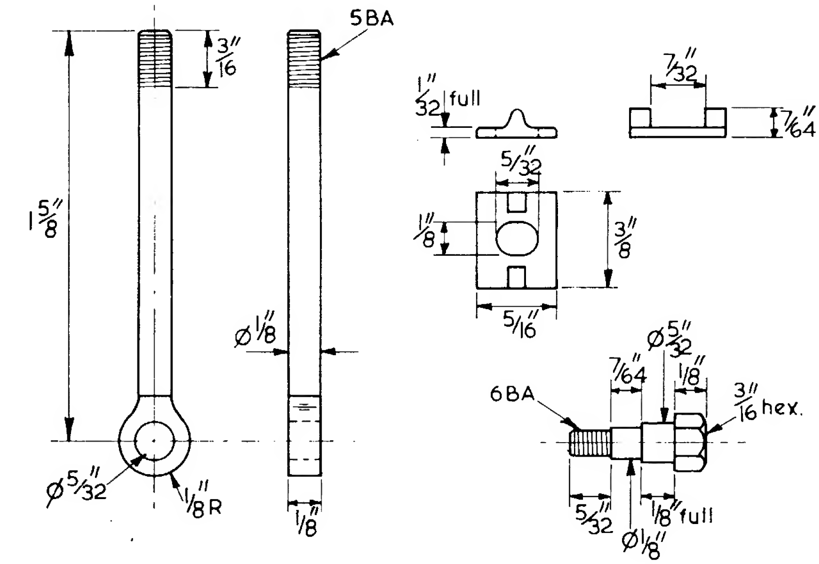
SPRING PIN GUIDE

4 off gunmetal

The spring pin guides are best made from flat bronze bar, 3/8 in. × ¼ in. being, I think, the nearest commercial size. Note that the No. 30 hole (through which the spring pins work) is located very close to the back of the fitting, so that when the guides are bolted to the engine frames, the spring pins should clear the frames by about 1/64 in. The flat washers which are fitted on top of each end of the top leaf of the springs (I couldn't think of a suitable name for them!) could be made from mild steel strip of 3/8 in. × 1/8 in. section. The oval hole is to allow the spring leaves to flatten as the axleboxes rise and fall in their horns. On assembly, the circular washer is put on, followed by a 5 BA nut and this nut must not be allowed to work loose, so either fix it with Loctite, or burr the end of the spring pin.

Crossheads

Back to some motion work now, starting with the crossheads. These could be cut from the solid mild steel, in which case the section required would be 1 3/8 in. × ½ in. The two crossheads could be cut from a blank arranged with their piston rod necks towards

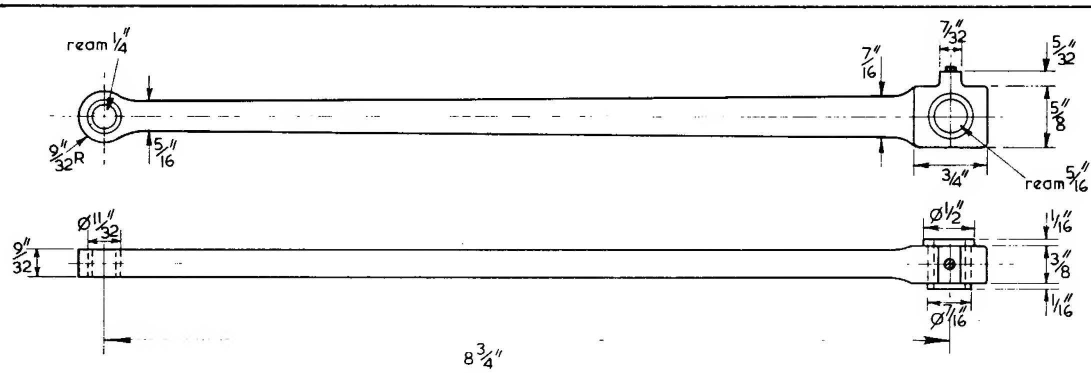


SPRING HANGERS, WASHERS & PINS

8 sets b.m.s.

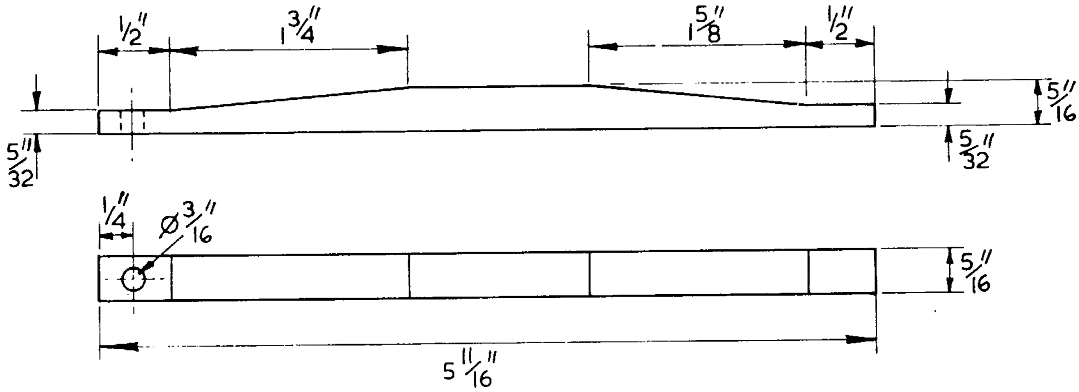
one another. After milling to a section of 1 5/16 in. × 7/16 in. the recess for the small end of the connecting rod is tackled. The way I generally do this is first to drill four holes, in the corners of the required recess, to the full depth needed, then follow up with an end-mill or slot-drill, in this case ¼ in. dia. to remove as much metal as possible. A 1/8 in. slot-drill is then used, followed by one of 3/32 in. dia. to get right into the corners. If the drill used at the start of the operation is not larger than 1/16 in. dia., the resulting recess is satisfactory, leaving only a slight radiusing of the connecting rod small end.

However, I expect at least one of our advertisers will be supplying gunmetal castings for the crossheads, and these would save a great deal of trouble. Furthermore, gunmetal works much better against steel slide bars then "steel-on-steel". Cast crossheads will only need cleaning up in the recess, the "slippers" for the slide bars milling out with a 5/16 in. end-mill or slot-drill, and the piston rod neck turning and drilling for its rod. To get a good close fit for the piston rod, drill in stages up to letter D, then ream ¼ in. as far as the reamer will go in, finally use a ¼ in. D-bit put in very slowly with plenty of cutting oil—this will ensure that it doesn't cut oversize. Some D-bits do seem to cut a bit oversize, so I strongly recommend trying it out on an odd gunmetal casting (drilling, reaming etc. first) and trying the actual piston rod for a good fit.

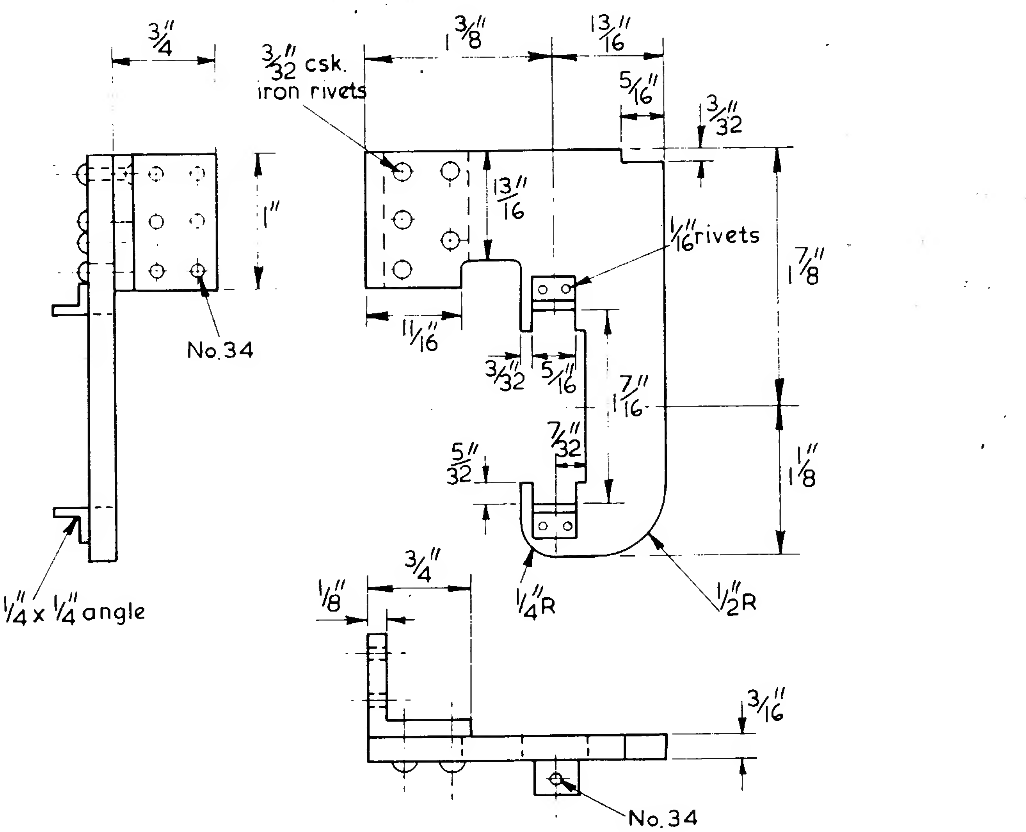


CONNECTING ROD L.H. drawn

b.m.s. bronze bushes

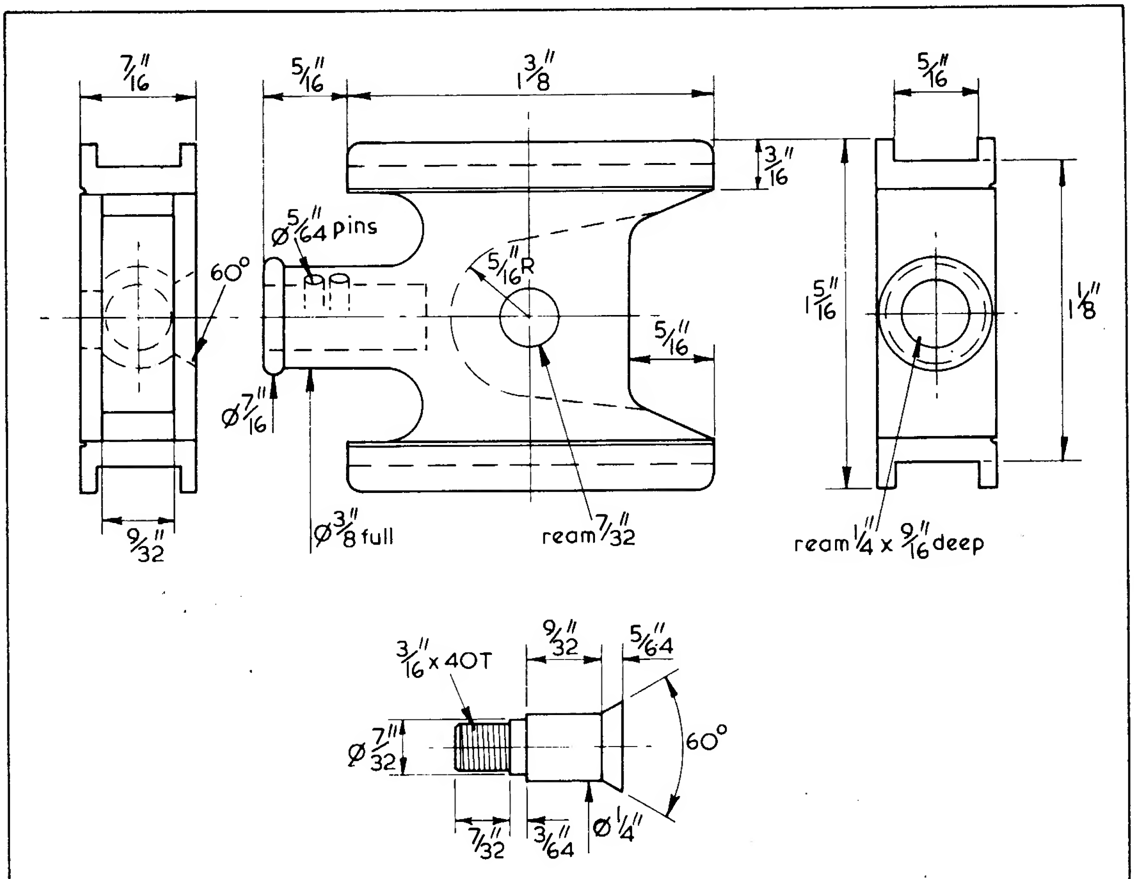


SLIDE BARS: 4 off silver steel



OUTSIDE MOTION PLATE (L.H. drawn)

1 pair b.m.s.



CROSSHEAD & GUDGEON PIN (L.H. drawn)

b.m.s. casehardened or from gunmetal casting

The slide bars won't need any description, being cut from 5/16 in. square silver-steel. Next, the connecting rods can be tackled, for which we need 7/8 in. (or 1 in.) × 3/8 in. mild steel. After marking one rod out, and drilling the two holes for the bushes, the first rod can be used as a drilling jig for the second. To reduce the rods to 9/32 in. thickness, apart from the big-ends, the ideal machine is a horizontal milling machine, but the same job can be done on most lathes, using the vertical-slide plus a length of stout angle (say 2 in. × 2 in. × ¼ in.) on which the rod is held by bolts through the bearings. The cutter (end-mill or Woodruff cutter) can then remove 3/64 in. from one side, up to about 1 in. from the small end (the head of the bolt holding this end preventing the cutter from going further of course). The rod is then turned over and its underside supported by a strip of metal of 18 s.w.g. (which is pretty close to 3/64 in. thickness) while the final cut is taken. Tip for beginners—take very light cuts only and use plenty of cutting oil, which will prevent the rod getting hot and warping). The final shaping can be done by sawing and filing, after which the bushes can be turned up and pressed home. Put the reamer through the holes again after the bushes are fitted, as the pressing-in process will compress them slightly.

Outside motion plates

These are quite easy to make, but they do need very careful marking out as we depend on them to keep the slide bars parallel to the frames and at the right spacing. Check for spacing by offering up one of the crossheads. Steel angle ¾ in. × ¾ in. is used to bolt the motion plates to the frames, while the ends of the slide bars are held securely by short pieces of ¼ in. angle (brass would do here at a pinch), but the operation of lining up and fixing the motion plates I must leave until next time. *Continued*

Erratum

I regret that an error occurred in the dimensions of the hornblocks in the May 16th issue. The overall height is 1 13/16 in. not 2 5/16 in.

CONWAY

A free-lance narrow-gauge 0-4-0 saddle tank locomotive for 3½ in. gauge

by Martin Evans

Part V

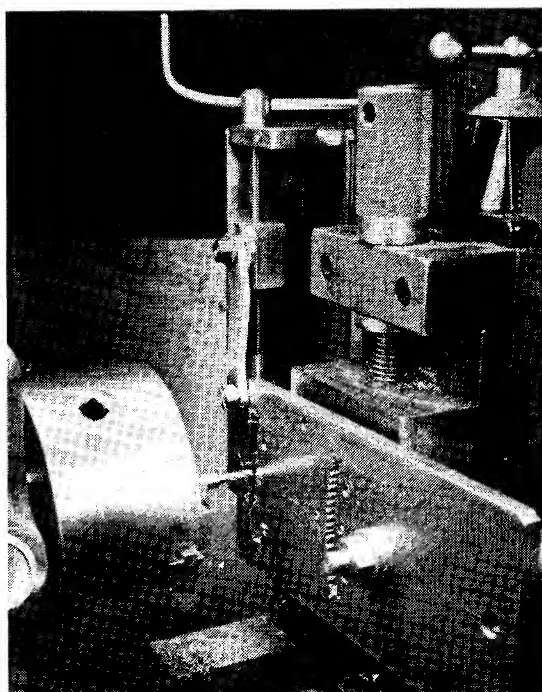
From Page 865

A FOLLOWER OF these notes has written in to say that the cab roof of our narrow-gauger is too low, unless the driver is under 5 ft. tall! But the relative height of the cab depends on what scale one takes the engine to be. If it is assumed that the model represents a locomotive to run on the very common 2 ft. 6 in. gauge, I agree that the cab roof is too low. But there is no reason to suppose that *Conway does* represent a 2 ft. 6 in. gauger. In fact, I was basing the design on a model to 1 1/16 in. scale, running on 3½ in. gauge, and on this basis, there would be plenty of head room for even a 6 foot driver!

Back to construction. I have now dealt with the cylinders, crossheads, slide bars, outside motion plates, coupling rods and connecting rods, so the next items to tackle are the valve gear components. As we have plenty of space between the frames in this design, the expansion links can be fitted with suspension pins on both sides. They are made from ¼ in. ground stock (gauge plate). This material is much tougher than mild steel and will give quite good service before wear sets in, even if left in the unhardened state. If hardened and tempered, and fitted with phosphor-bronze die-blocks, they should last for "ever and a day", as the late LBSC would have said! It is true that hardening expansion links often leads to distortion, but as in this case there is plenty of metal all around the slot, I don't think there should be any trouble.

Those who are experts at filing can make their links by drilling out most of the unwanted metal and then finishing the slots by hand, in which case it is a good plan to make the die-blocks first and use these as a gauge. Needless to say, the hole in the die-blocks should be drilled and reamed to size before the outside is finished, and this precaution should also apply to the links, so make sure of a good clean slot before sawing and filing the outside. Making some die-blocks for my 5 in. *Claud* the other day — from flat phosphor-bronze — I quite forgot this precaution, I shaped the outside surfaces to a perfect fit on the links (which I had previously made on my lathe attachment) and then drilled the hole off-centre. As the hole in this case had to be counterbored, to take a retaining bolt and washer, they had to be scrapped!

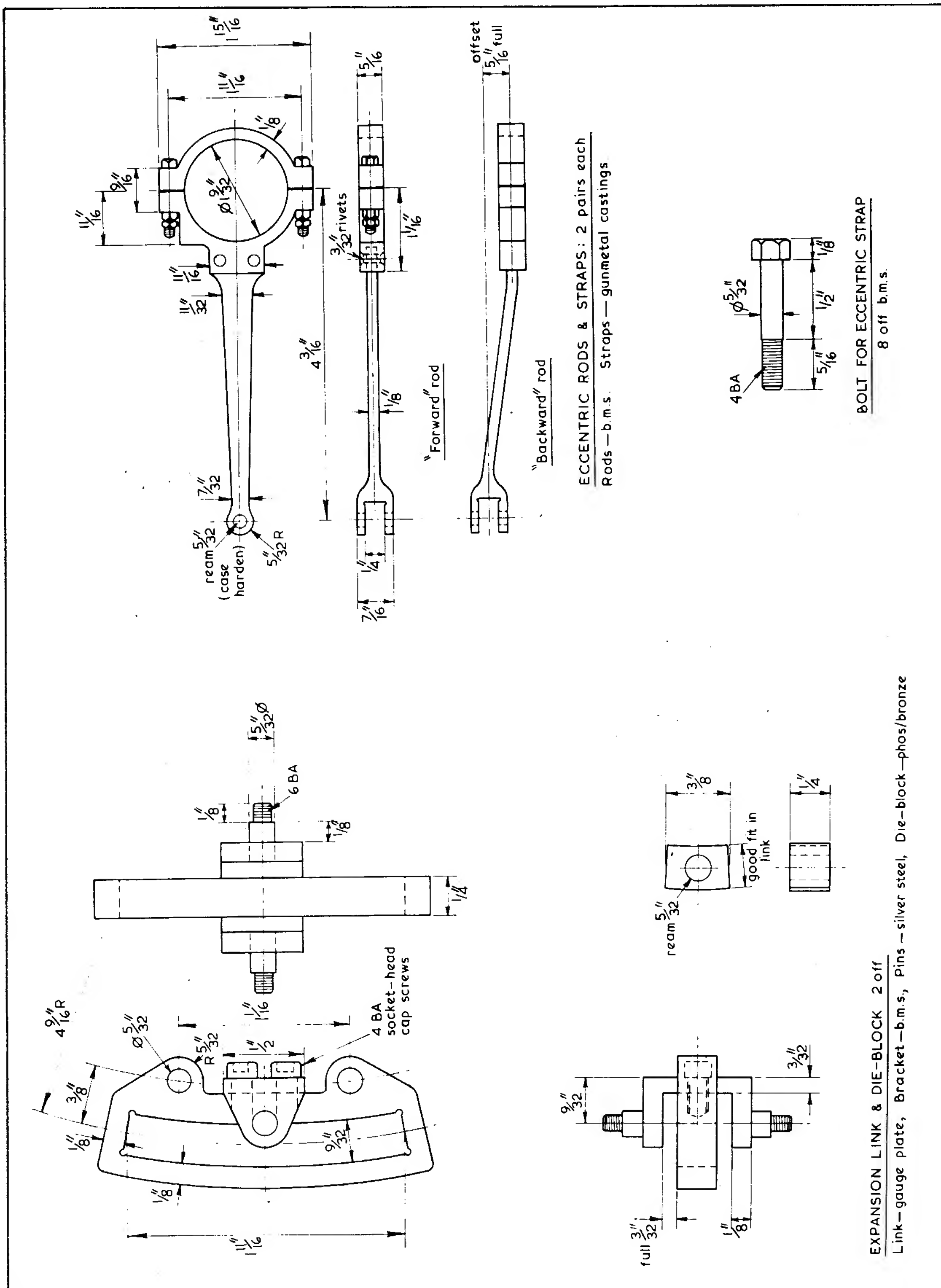
Returning to the expansion links, those who, like me, are not exactly brilliant with files will no doubt wish to end mill the slots in the lathe. Beginners are, therefore, strongly advised to make up a proper milling attachment first, a drawing of a suitable one (WE.12) is available from the M.A.P. Plans Service.



Milling the curved slot in an expansion link.

Having set this up in the lathe, with the link blanks previously marked out and much of the unwanted metal drilled out, a 3/16 in. diameter end-mill will make short work of the slots, but the lathe should not be run too fast if gauge plate is being used, and plenty of cutting oil is desirable, to keep the end-mill cool and sharp.

The link brackets can be made from ½ in. square mild steel, the slot being milled out, and the two pins machined from 5/32 in. diameter silver-steel press-

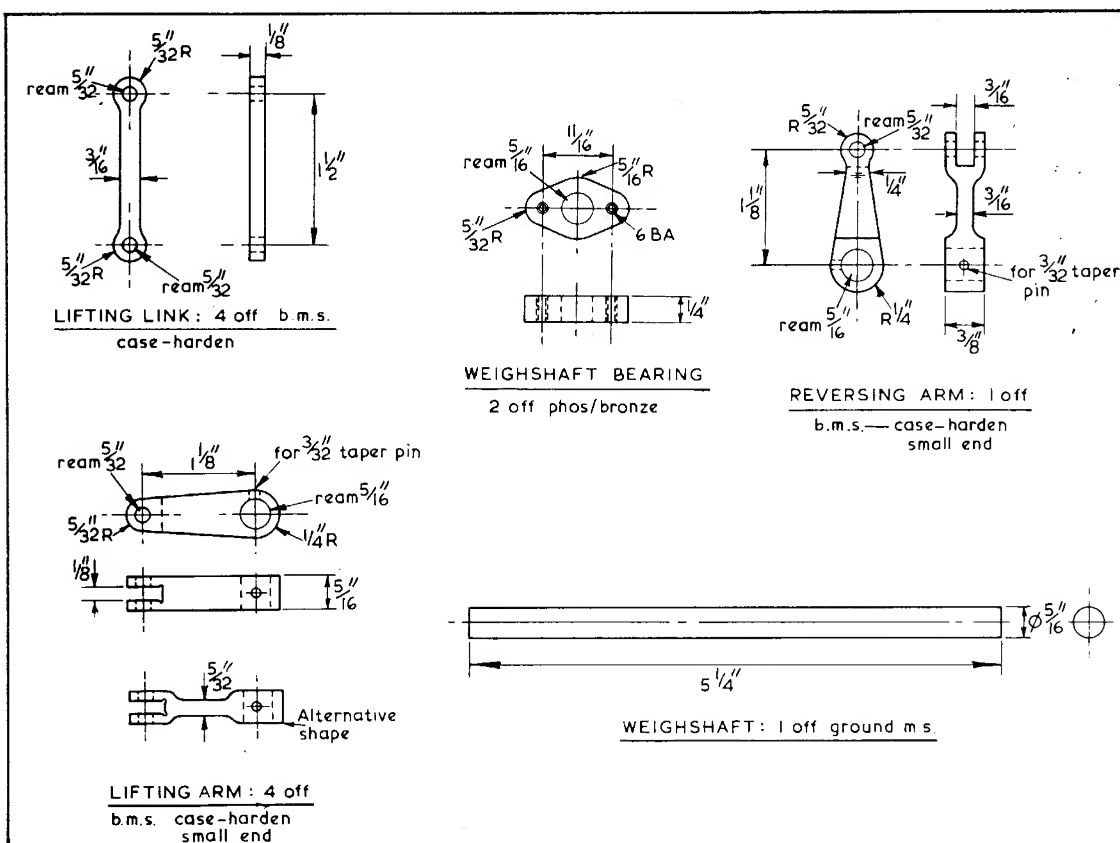

ECCENTRIC RODS & STRAPS: 2 pairs each
Rods—b.m.s. Straps—gunmetal castings
"Forward" rod
"Backward" rod
offset 5/16" full
3/32" rivets
ream 5/32" (case harden)
5/32" R
BOLT FOR ECCENTRIC STRAP
8 off b.m.s.
4 BA
EXPANSION LINK & DIE-BLOCK 2 off
Link—gauge plate, Bracket—b.m.s., Pins—silver steel, Die-block—phos/bronze
4 BA socket-head cap screws
6 BA
ream 5/32"
good fit in link
full 3/32"

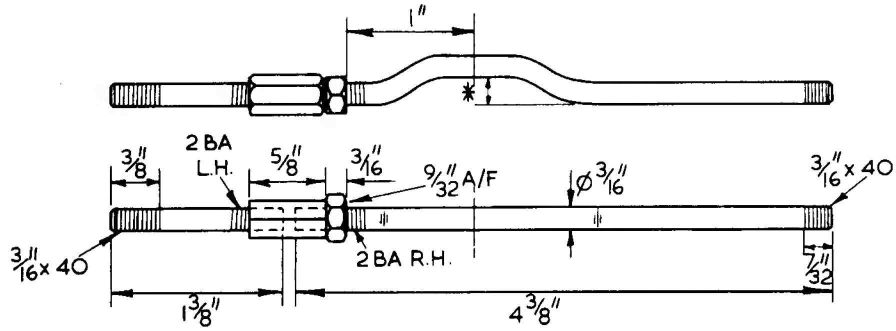
fitted. The brackets are held to the back of the links by two 4 BA socket-head screws, so there will be no need for any brazing here.

Now for the eccentric rods and straps. The straps are first cleaned up as much as possible by filing; the bolt holes are drilled and reamed 5/32 in. diameter (right through) and the straps then sawn in half. The bolting faces are next filed true and square, the bolts turned up from 3/16 in. A/F hexagon steel, and the two halves of the straps bolted together. Before boring the straps, turn up a short length of round mild steel to exactly the same diameter as the eccentrics; this can then be used as a gauge and, after the boring has been completed, the same bar can be used to mount the straps while the sides are being machined. The slots to take the ends of the eccentric rods can be quickly milled out, using first a 3/32 in. diameter end-mill, then one of 1/8 in. diameter, the strap being held on its side in the machine vice clamped to the vertical-slide.

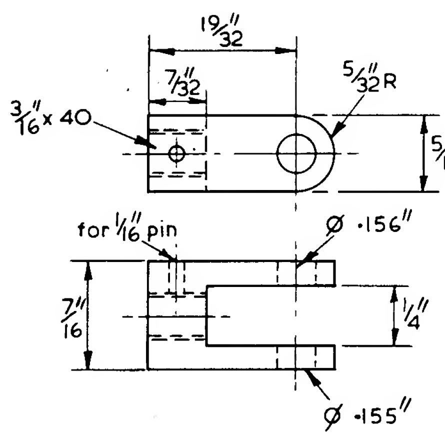
The eccentric rods are cut from ¾ in. × ½ in. mild steel. The four pieces required are first reduced to a section of 11/16 in. × 7/16 in. then the "link end" is drilled and reamed 5/32 in. diameter and slotted out ¼ in. wide. To reduce the remainder of the rods to 1/8 in. thickness, either milling can be used, or the excess can be sawn and filed away. Leave excess length here, especially for the "backward" rods, which have to be off-set quite considerably. Next, a jig will be required, to ensure that all four eccentric rods and straps are the same length. This could consist of a piece of steel about 2 in. × ¼ in. section and about 6 in. long. For the link end of the rods a 5/32 in. diameter silver steel pin, about ¾ in. long, is pressed in and for the strap end, a disc of steel the same diameter as the eccentrics and at least 3/8 in. thick is located at 4 3/16 in. centres from the 5/32 in. pin. This disc is best tapered off very slightly, to permit easy assembly of the straps. The length of the eccentric rods is now arranged so that the forked ends of the rods slip over the 5/32 in. pin, and the straps over the disc, the bends in the "backward" rods being put in beforehand of course. Two 3/32 in. rivets, countersunk lightly on both sides, will be sufficient to hold the rods firmly in their straps.

Four lifting links are required next, these being very simple, cut from 5/16 in. × 1/8 in. mild steel, with the "eyes" case-hardened. The four lifting arms are slightly more elaborate, as these are slotted out 1/8 in. to a depth of slightly more than 5/16 in., this being done after the holes are drilled and reamed. Aim for a

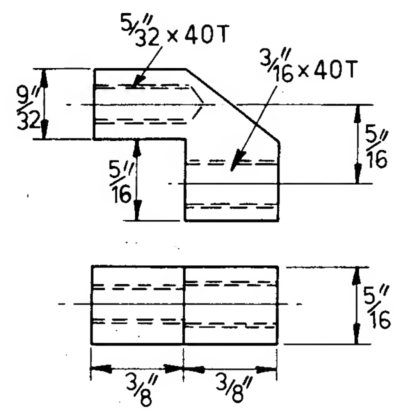




INTERMEDIATE VALVE ROD: 2 off stainless stl.
* 3/16 full – to clear leading axle



INTERMEDIATE VALVE ROD CROSSHEAD
2 off b.m.s.



VALVE SPINDLE COUPLING
B.M.S.

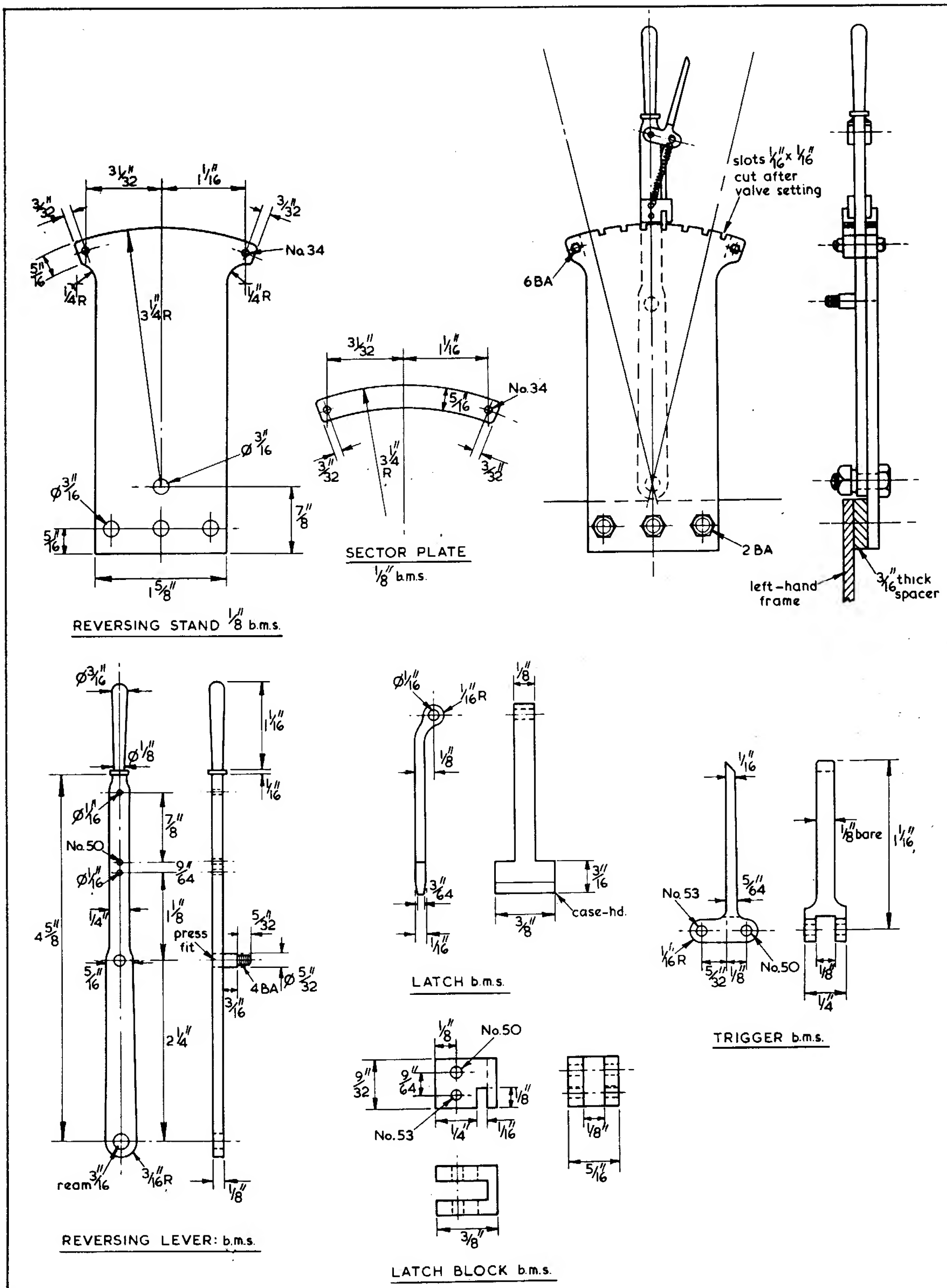
good fit on the weighshaft, which is just a length of 5/16 in. diameter ground mild steel. The single reversing arm is cut from ½ in. × 3/8 in. b.m.s. and is slotted out 3/16 in. by 11/32 in. depth for the reach rod, and drilled and reamed to be a good fit on the weighshaft.

To make valve setting easy, the intermediate valve rod incorporates a coupling with a left and right-hand thread; I have suggested 2 BA, as this size is easier to obtain in left-hand than 3/16 in. × 40T. Note the "set" in the longer part of the rod, to clear the leading axle. The locknut tightened against the coupling is essential, to prevent the whole intermediate valve rod twisting round and fouling the leading axle.

The intermediate valve rod crosshead (rather a long title I'm afraid!) is made from 7/16 in. × 5/16 in. b.m.s. or the nearest larger. One end is drilled and tapped 3/16 in. × 40T, while the other end is slotted ¼ in. to embrace the expansion link, but the 5/32 in. holes must be dealt with first. As the die-block pin is to be made a press fit in this crosshead, these holes must be left a shade under the exact 5/32 in. diameter. One way to achieve this is to drill right through with a drill about No. 25, follow this with No. 23, then mill out the slot. Next, put a 5/32 in. diameter reamer through, but only up to just short of the end of the "lead" of the reamer; this should leave things just right for a 5/32 in. diameter pin.

Cab reverser

Before we can make the reach rod and assemble the valve gear for keeps, the cab reverser should be made. The stand is cut from 1/8 in. steel plate; saw and file to outline but don't cut the notches just yet. It is bolted to the outside of the left-hand frame, with a 3/16 in. thick spacer between, to bring the reach rod well clear of the firebox. The sector plate is also cut from 1/8 in.



REVERSING STAND 1/8" b.m.s.

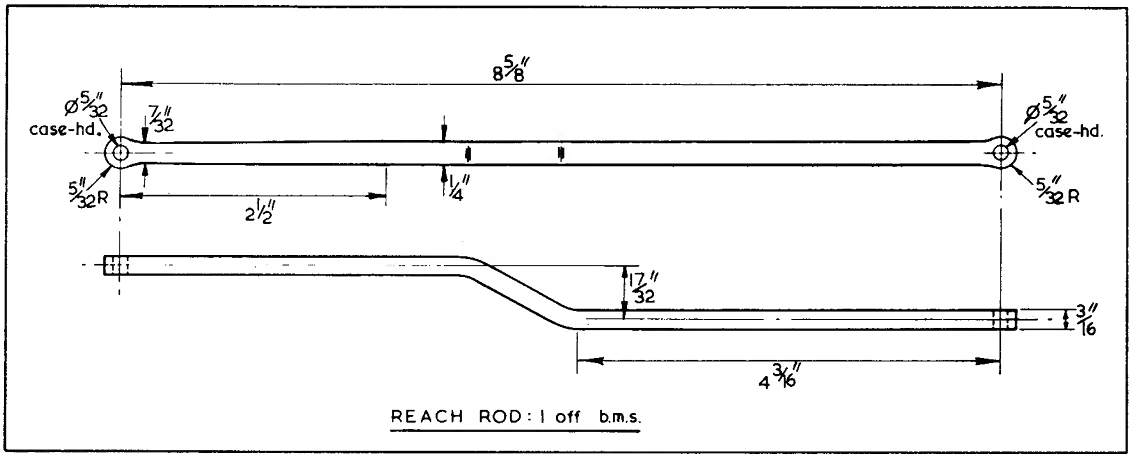
SECTOR PLATE 1/8" b.m.s.

REVERSING LEVER: b.m.s.

LATCH b.m.s.

LATCH BLOCK b.m.s.

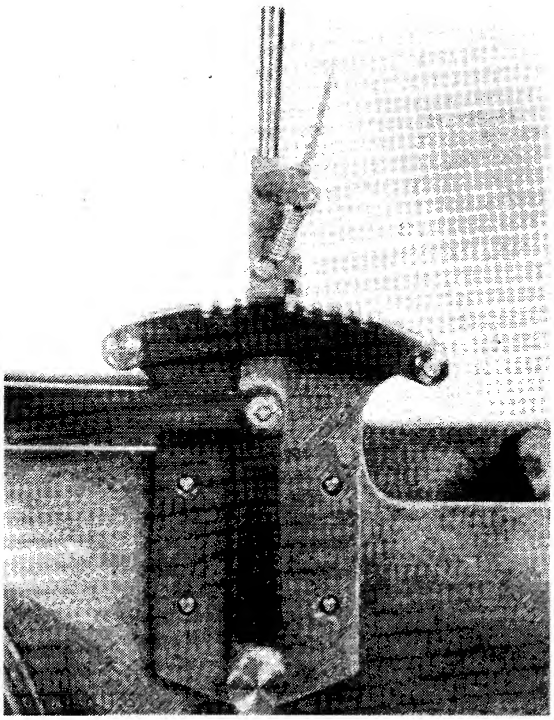
TRIGGER b.m.s.



steel, and is bolted to the top of the stand by 6 BA screws at each end, with spacers which should be a few thou over 1/8 in. thickness, to give working clearance for the lever.

The lever is made from 3/8 in. × 1/8 in. b.m.s. To permit the handle to be turned to a bare 3/16 in. diameter at the top, the old dodge can be used — heat the end to bright red and give it a good squeeze in the bench vice. The lever can be held firmly in the 4-jaw for the turning. Of the three small holes near the top of the lever, the two drilled 1/16 in. diameter are for

A lever reverser similar to that for Conway.



1/16 in. silver steel pins, the lower one to be lightly countersunk on each side, to hold the latch block firmly, while the No. 50 hole is for a 10 BA screw, the head of which also serves to hold the end of the spring. The 5/32 in. diameter pin for the reach rod is made a press fit in the lever.

The latch block is made from 3/8 in. × 5/16 in. b.m.s., cross drilled as shown, then slotted 1/8 in. wide for the lever and again, vertically, 1/16 in. for the latch. The latch, which should be case-hardened at the bottom end, can be cut from 3/8 in. × 1/8 in. b.m.s., the hole at the top being drilled 1/16 in. diameter. The trigger is made from ½ in. × ¼ in. section — rather a waste of metal here, but cutting from the solid avoids a tricky brazing operation. Most of the unwanted metal can be removed by sawing, while the 1/8 in. slot across the bottom end can be milled, after the holes are drilled and before the "handle" part is shaped.

Before assembling the reverser, the position for the central or "mid-gear" notch can be found by temporarily clamping the lever exactly vertically. This notch can then be cut and the assembly completed, slipping over the 10 BA bolts a tension spring about 1/16 in. diameter and about 30 s.w.g. (Reeves stock a spring just right for this.)

The reach rod is made from 5/16 in. × 3/16 in. b.m.s. Drill and ream the hole for the reversing arm, and shape that end, then put in the 17/32 in. offset, leaving the cab end over-size, or rather over-length, for the moment. Couple up the reach rod to the reversing arm and set the expansion links exactly central, clamping them lightly. The reach rod can then be "offered up" to the reversing lever and the exact length determined, when any excess rod can be cut off and the hole drilled and reamed. The whole valve gear can then be given a temporary assembly and the wheels turned to make sure that there are no "fouls" anywhere. After this, any temporary pins can be replaced by silver steel or hardened ones, when we will be ready for valve setting.

Continued

CONWAY

A free-lance narrow-gauge 0-4-0 Saddle Tank locomotive for 3½ in. gauge

by Martin Evans

Part VI

From Page 991

BEFORE MAKING a start on the boiler, we might set the valves. As there is plenty of room between the frames in this locomotive, it should not be too difficult to see the movement of the valves over their port-faces once the steam chest covers have been removed. First make sure that the usual gasket has been put between the steam chest and the cylinder block, or that Hermetite or similar jointing has been applied; then temporarily bolt the steam chest in place without its cover. In this design, the full gear valve travel is ½ in., and the lap of the valves is 1/8 in., so that the eccentrics should be ahead of their respective main crank by 90 deg. plus 1/8 in., so arrange the eccentrics as near as you can get them to this position, *lightly* fixing them to the driving axle.

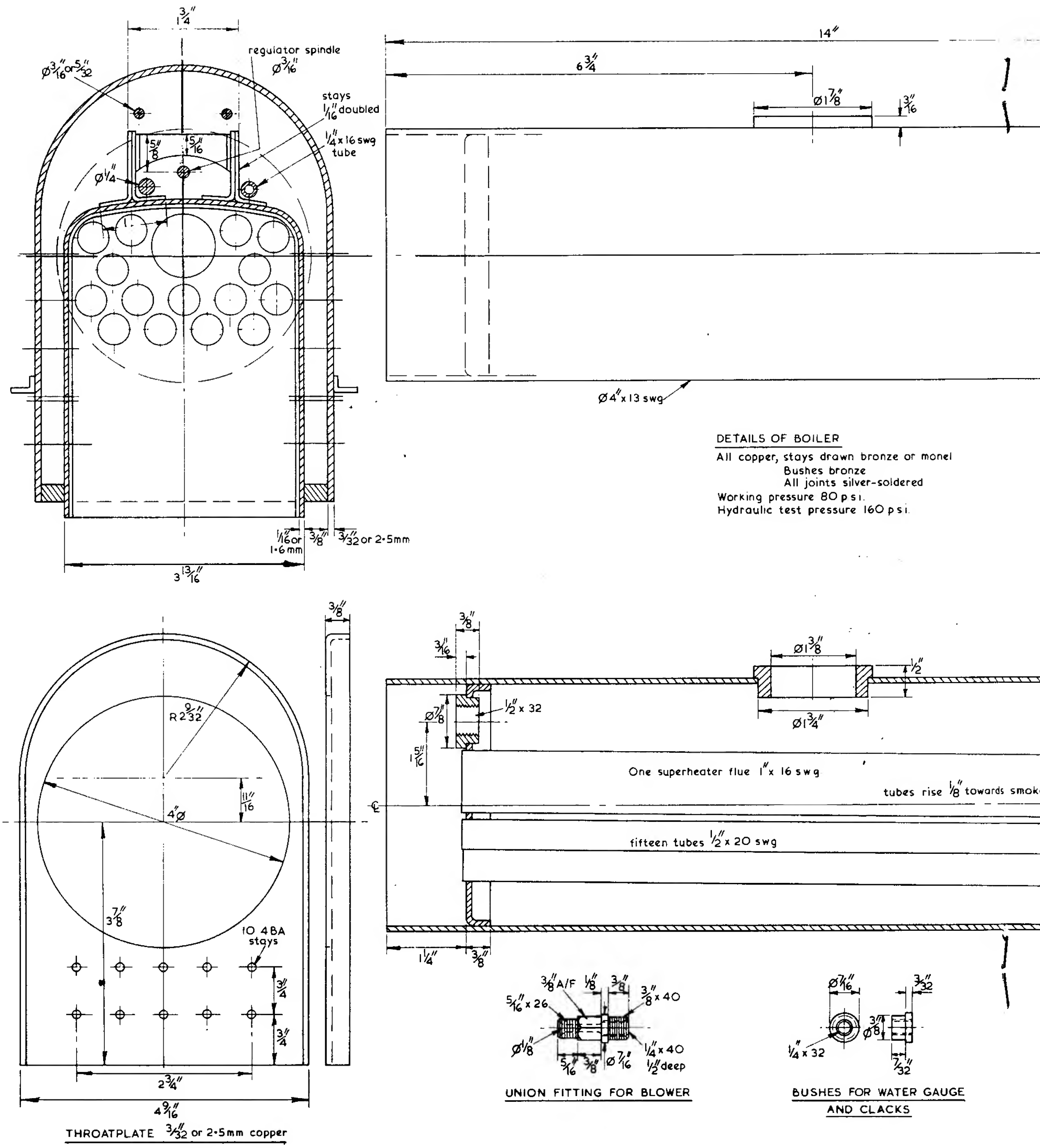
Next, push the reversing lever right forward, turn the wheels slowly in a forward direction and watch the movement of the die-block in the expansion link very closely. If the die-block hits the extreme end of the link slot, at the same time giving the reversing lever a kick, the lever is too far forward, so bring it back a shade until the die-block in its extreme position clears the end of the slot comfortably. This is now the correct full forward gear position for the reversing lever, so the notch in the quadrant can now be cut to take the latch in this position. Repeat the above process with the lever right back and turning the wheels in a backward direction. When correct, cut another notch for the full backward gear position. We can now turn our attention to the movement of the valve. Put the reversing lever in the full forward gear notch and turn the wheels in a forward direction again. If the valve does not open the ports equally at each end of the cylinder, adjust the intermediate valve rod until it does.

Now remove the back halves of the eccentric straps of (say) the right-hand valve gear, slacken the eccentric grub screws just enough to enable the eccentrics to be moved around their axle, then replace the straps. Put the right-hand crank on front dead centre (exactly!) and turn the forward gear eccentric until the front port is just about to open (the port should show as a very thin black line at this point). Tighten the grub screw in this eccentric, but not so tightly that it bites into the axle and makes a definite depression, re-assemble its strap. Turn the wheels in a forward direction again until the crank is at the back dead centre. If everything is correct, the back steam port should be just about to open. Repeat the whole operation on the back gear eccentric with the reversing lever in the backward full gear position and turning the wheels in a backward direction.

Now it may be that having got one end of the cylinder correct, the valve does not open the steam port at all at the other end, in other words the wheels have to be turned a little further before the "black line" of the port can be seen. This means that the valve is a shade too long for its ports, so it will have to be taken off and a shade machined off BOTH ends, keeping the recess central. After re-assembly, the whole process must be gone over again.

The above method of valve setting is setting to "equal leads" and, to get the best results, one should really set to equal cut-offs at some previously decided point of cut-off. To do this, choose some point on the reversing lever quadrant which would represent a suitable cut-off for the full-speed running with a moderate load. In the case of *Conway*, I would suggest slightly nearer to the full-gear position than to the mid position. Make a light mark on the quadrant, both sides of central, and lightly clamp the reversing lever. Now we can't see the position of the piston in the cylinder, but we can obtain an approximate position by making a light mark on the outside of the driving wheel. At this point, we must remember that when the crank is at exactly downwards at 90 deg. to the horizontal, the piston is a short distance past its mid-point. In other words, the piston has moved from front dead centre half the stroke plus this extra distance, which we can call "x". But when the crank moves from back dead centre to the vertically upwards point, or 270 deg., the piston has moved half the stroke minus "x".

To check the actual port openings at the decided positions of the crank we can't insert a feeler, as the feeler required for the job would be too thick to be bent (it will have to be bent roughly at right-angles before we can insert it into the port) so obtain a few pieces of brass wire, or, if necessary, turn a few pieces in the lathe plus or minus a few thou. either side of the dimension required to fit the port opening. When the necessary adjustment of the eccentrics has been carried out to obtain the desired equal cut-offs, the grub screws in the eccentrics can be tightened down for good and the straps replaced and bolted up firmly. It will probably be found that when all the straps have been finally bolted up that the motion has become



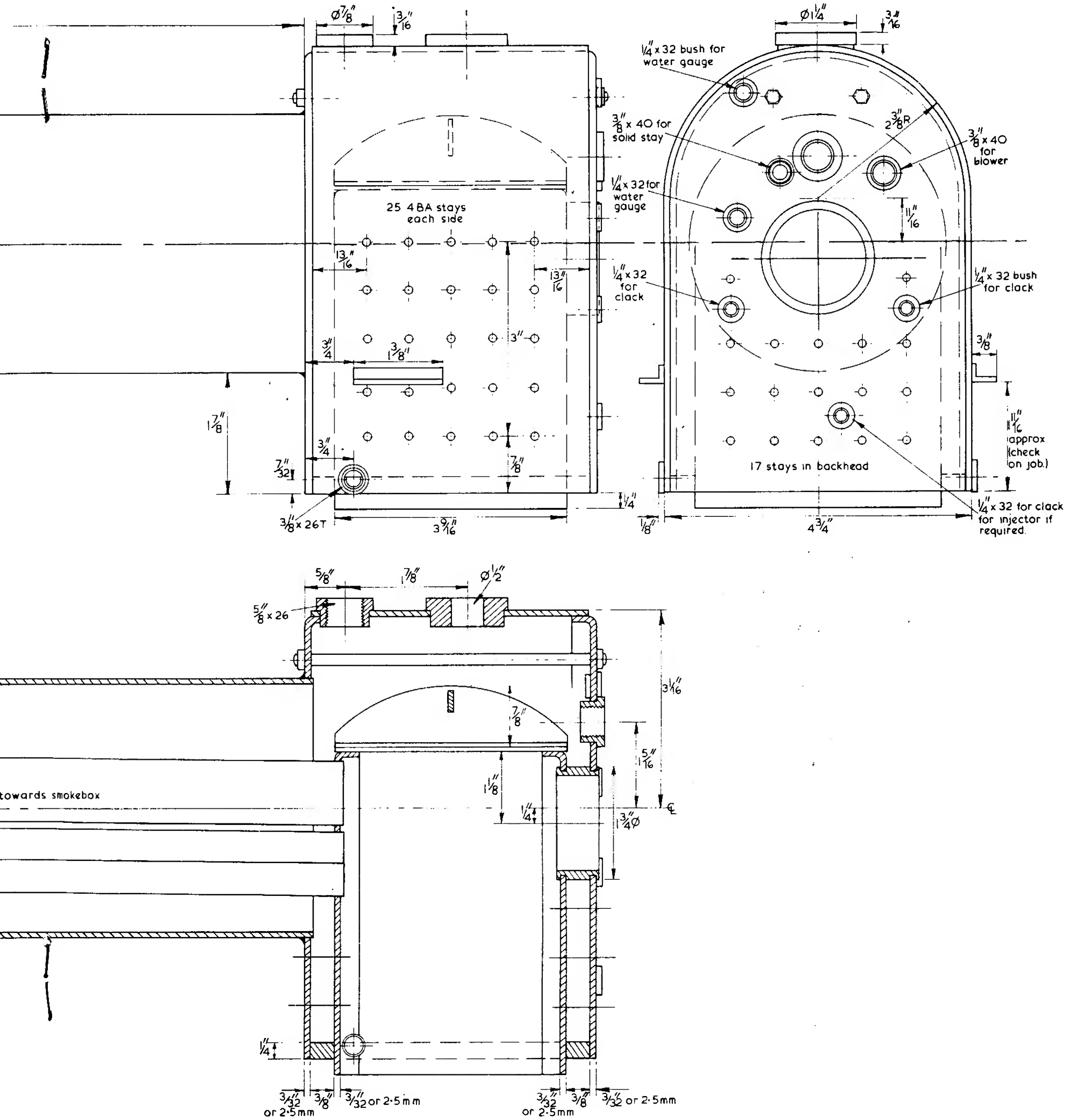
DETAILS OF BOILER

All copper, stays drawn bronze or monel
Bushes bronze
All joints silver-soldered
Working pressure 80 p.s.i.
Hydraulic test pressure 160 p.s.i.

THROATPLATE 3/32" or 2·5mm copper

UNION FITTING FOR BLOWER

BUSHES FOR WATER GAUGE AND CLACKS



Ø7/8"
3/16"
25 4BA stays each side
13/16"
3"
3/4
1 3/8"
1 7/8"
7/32"
7/8"
3/8"x 26T
3 9/16"
1/4"
Ø1 1/4"
3/16"
1/4" x 32 bush for water gauge
3/8" x 40 for solid stay
2 3/8"R
3/8" x 40 for blower
1/4" x 32 for water gauge
11/16"
1/4" x 32 for clack
1/4" x 32 bush for clack
3/8"
11/16" approx (check on job.)
17 stays in backhead
1/8"
4 3/4"
1/4" x 32 for clack for injector if required.
5/8"
1 7/8"
Ø1/2"
5/8" x 26
3 1/16"
7/8"
1 5/16"
1 1/8"
1/4"
1 3/4"Ø
towards smokebox
3/32" or 2·5mm
3/8"
3/32" or 2·5mm

rather stiff. However, if the whole job is given a thorough oiling with a light oil (Shell Vitrea or similar) and the wheels turned for a good time, things are sure to get easier.

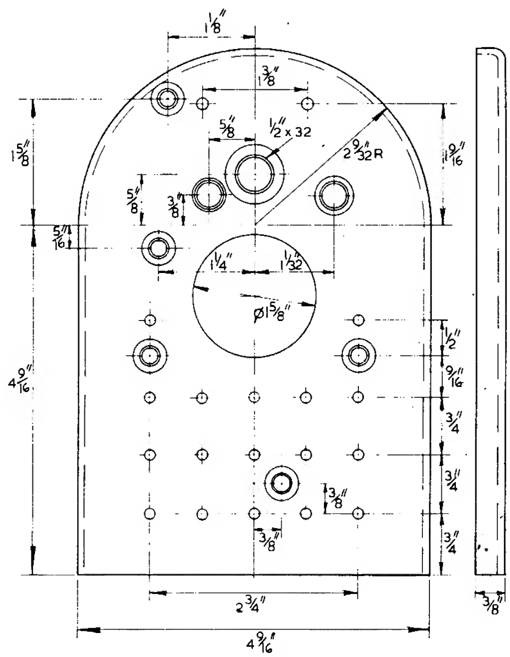
After the valve setting has been completed, the remaining notches in the reversing lever quadrant can be cut — there should be plenty of room for two or even three notches between mid gear and full gear at each side of central.

The Boiler

Just before we start on the boiler, perhaps a word or two on the question of keeping that old enemy — rust — at bay, while we start gathering the materials, silver-solder, etc., etc. In most amateur workshops, rust is a terrible problem. In my own workshop, which is actually a double-garage with the car occupying one half, I cannot leave any bright steel part lying about during the winter months for more than a day or two before rust sets in; even the table of my drilling machine, which is of cast-iron, gets an unhealthy brown colouration after a couple of days unless oiled or covered with something (an oily rag generally). Maybe the exhaust of the car, when coming in or leaving, adds to the problem. While the inside of the frames of our *Conway* will probably have been painted before final assembly, the bright steel parts, valve gear, connecting rods, etc., can't be painted; but one useful suggestion is to paint a light coat of ordinary picture varnish on all bright parts, apart from where some adjoining part is working against them. When this is quite hard, Shell "Ensis" or similar water-repelling oil is sprayed on.

Now for the boiler. Although much has been written in *Model Engineer* about boiler making for the amateur, it seems that quite a few locomotive builders find boiler-making more difficult than machine or chassis work, and we still see the occasional small advertisement — "finished locomotive chassis, complete with boiler materials, for sale"! This is rather difficult to understand, because in many ways, boiler work is *easier* than chassis work and, furthermore, it does not take nearly so long provided the essential equipment is available. Whereas in chassis work, we have to work frequently to "thous" (sometimes even to half-thous!), on boilers, we shall not do too bad if we are within 1/32 in. on the longitudinal dimensions, or 1/64 in. on our widths.

Conway's boiler is very different from those on most main-line locomotives. The firebox is much higher than the barrel, the barrel is long in proportion to the length of the firebox, while the firebox in end view looks more like that of a traction engine boiler. However, it should not be at all difficult to make. For the barrel, we required a 14 3/16 in. length of seamless copper tube, 4 in. diameter and 13 s.w.g. (3/32 in.), and the first operation will be to turn the ends true, using the old dodge of plugging the ends with wood, something about ¾ in. thick if possible and, as the barrel is an unusually long one, a metal "centre" can be bolted in the middle of the wood so that tailstock support can be given. Next, cut the hole for the dome bush, by drilling a row of small holes just inside a scribed line, breaking out the unwanted metal and filing to size. It helps greatly here, if the gunmetal bush is turned up beforehand, as this can be used to scribe around. Make the bush a tight fit, and this can be silver-soldered in place before we proceed any further, using Easyflo No. 2 for preference. Incidentally, I very much hope that the price of silver-solders will have come down a bit by the time this article appears in print; the extremely high price of anything containing silver had apparently been forced up by speculators a short time ago!



BACKHEAD : 3/32" or 2·5 mm copper

The various flanged plates can now be taken in hand, these are the backhead, the firebox tubeplate, firebox backplate, throatplate and smokebox tubeplate and they are all made from 2.5 mm (or 3/32 in.) copper sheet. I believe that Reeves of Birmingham may be supplying plates ready flanged for this locomotive, which will save a great deal of work without much additional expense (usual disclaimer). Those making their own flanged plates need not go to the hard work of cutting their formers out of ¼ in. thick steel — 1/8 in. steel glued to a backing of hardwod is perfectly satisfactory and bakelite is also suitable for a "one-off" plate. The outer wrapper of the firebox can

be made next, cut from 2.5 mm or 3/32 in. copper sheet. The inner radius of the top of this wrapper is 2 9/32 in. so it should be quite an easy job bending it (after annealing) over the barrel.

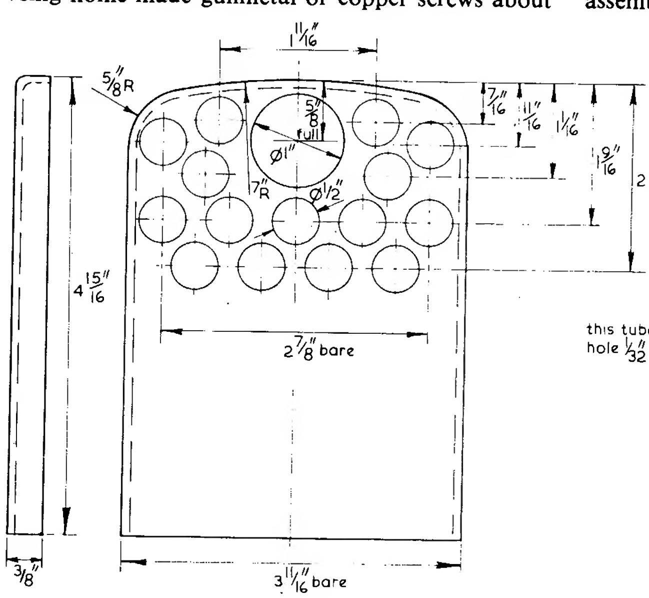
The outside dimensions of the throatplate are identical to those of the backhead, the same former being used. A 4 in. diameter hole is cut in the throatplate to receive the end of the barrel and this hole can be cut by fly-cutting in the lathe. First though, drill all the holes that will be required later for the stays, that is ten below the barrel, which are drilled No. 32 (tapping size for 4 BA) and two for the stays above the barrel which will be needed between this plate and the backhead. Drill these 1/8 in. as these will be later tapped 5/32 in. × 40T; their dimensions can be taken from those given on the backhead. Having drilled the holes, we now have something by which the plate can be clamped, on its side, to two angle plates bolted to the lathe cross-slide, with the flange towards the lathe headstock.

After successfully cutting the 4 in. diameter hole, chamfer this all the way round on the barrel side, so as to leave a decent groove for the silver-solder to fill. The throatplate can now be silver-soldered to the barrel. I would strongly recommend the use of Easyflo No. 2 for this joint, as it is absolutely essential that this joint be sound. Form a good fillet of the solder all around. It may be asked how the barrel can be held quite square to the throatplate while the silver-soldering is being carried out. I would suggest that two little tabs, say of 1/16 in. thick copper, can be screwed between the two, one at the top and one at the bottom, using home-made gunmetal or copper screws about 6 BA. These tabs need not be larger than ¼ in. wide, bent to form a little angle ¼ in. × ¼ in. They must be run over with the solder of course; the bottom one will have to filed away a little to keep clear of the middle stay hole.

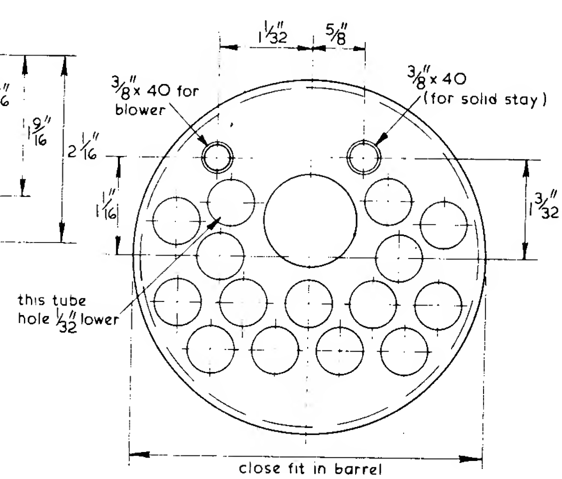
At this stage, it is not a bad idea to turn up the two big bushes which are fitted to the top of the outer wrapper. The smaller one, tapped 5/8 in. × 26T, is for the safety valve, while the larger, plain, bush is for the usual turret, which will be bolted down. These bushes can now be brazed in place.

Tackle the firebox plates next. After setting out all the holes in the firebox tubeplate, drill 1/8 in. diameter then this plate can be clamped to the smokebox tubeplate and the drill run through this too. But don't forget to allow for the rise of the tube bank — by 1/8 in. — towards the smokebox end! The tube holes can be drilled 31/64 in. diameter initially, then a ½ in. diameter reamer put through but only halfway up the "lead" of the reamer, so that the holes are left a few thou under the nominal ½ in. The 1 in. diameter hole for the superheater flue should also be left a few thou undersize, and this can be bored in the lathe using a headstock boring tool, the plate being clamped in a similar manner to the throatplate, except that this time we can use a few bolts with large washers put through some of the tubeholes. To complete the smokebox tubeplate, open out the tube holes to a full ½ in. diameter and the superheater flue hole to 1 in. diameter and lightly chamfer these on the smokebox side. The tapped bush for the main steam pipe can be turned up from gunmetal and brazed to the plate before assembly.

Continued



FIREBOX TUBEPLATE
3/32" or 2·5 mm copper



SMOKEBOX TUBEPLATE
3/32" or 2·5 mm copper

CONWAY

A free-lance narrow-gauge 0-4-0 Saddle Tank locomotive for 3½ in. gauge

by Martin Evans

Part VII

From Page 1133

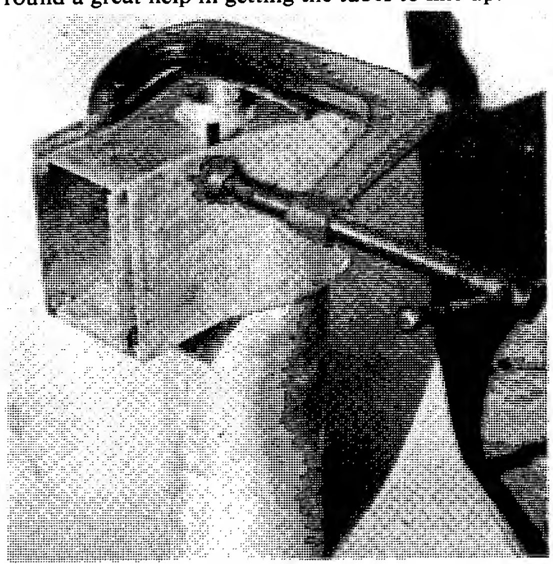
TO CONTINUE WITH the building of the boiler, the next operation is to make up the inner firebox, bending the wrapper, after thoroughly annealing the 2.5 mm copper sheet, and coaxing it around the firebox tubeplate and backplate; a few 1/16 in. snaphead rivets put in at strategic places will hold it ready for silver soldering, but do not solder the backplate at this stage, it can be held in place temporarily by a few screws.

Make up the crown stays now, these are bent up from 1/16 in. (1.6 mm) copper, with their "feet" riveted to the crown of the wrapper, and a stiffening cross-piece arranged centrally. As the longitudinal stay and the hollow blower tube come very close to the feet of the crown stays (see cross-section), it is advisable to put the rivets in from the underside and hammer their shanks into countersinks on the outside, so that they will lie quite flush. Two 3/32 in. rivets should be ample to hold each crown stay "foot"; gunmetal screws and nuts may be used if preferred.

The firebox tubeplate is now silver soldered to its wrapper and the crown stays are also dealt with at this stage, not forgetting to run some solder over the rivet or bolt heads. The firebox backplate can now be removed while we tackle the fitting of the tubes.

The tubes and single superheater flue are all 13½ in. long, the flue being 1 in. diameter and 16 s.w.g. thick, and the tubes ½ in. diameter and 20 s.w.g. (18 s.w.g. tubes could also be used if preferred, the extra thickness won't make any appreciable difference to steaming, but I would not advise anything thinner than 20 s.w.g.) The tubes can be squared off in the lathe, and the ends that are to fit in the firebox tubeplate turned down by not more than 3 thou, for a length of 3/16 in. This will ensure that they cannot slip right through the tubeplate during heating operations. Unless the builder has a big lathe that will take 1 in. diameter through the spindle, the superheater flue will have to be held in the 3-jaw with its outer end supported in a steady.

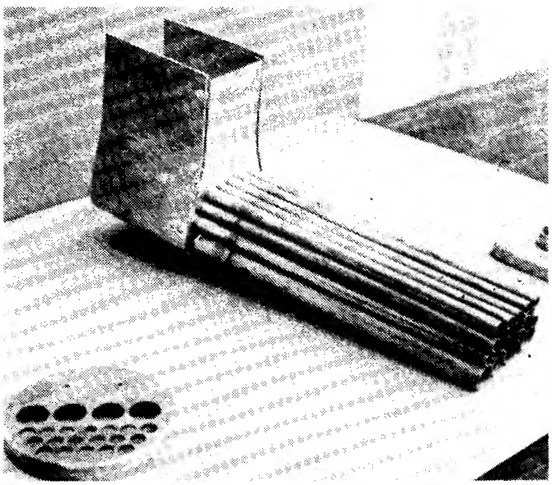
Before fitting the tubes to the firebox tubeplate, file three or four little nicks in the holes, to ensure that the silver solder will flow right through and form a sound joint, the nicks need not be deeper than about 12 thou or so. I find that Easyflo silver solder in wire form is the best thing for fixing tubes; it can be obtained in 1/32 in. diameter. This is wound round each tube in turn — at least two complete turns to each — and pressed hard up against the tubeplate. The smokebox tubeplate can now be used to hold the outer ends of the tubes in line while silver soldering is carried out. What a fiddling job it is to get all the tubes through! As soon as most of the tubes are safely through, one or two will insist on slipping out again and one has to start all over again! But the sharp end of an ordinary pencil will be found a great help in getting the tubes to line up.



Bending up an outer firebox wrapper prior to fitting the backhead.

The assembly can now be set up in the brazing pan with the tubes pointing upwards and the tubeplate horizontal, checking that the tubes have the slight rise shown on the drawing towards the smokebox end. As the tubes are unusually long, some additional support may be needed at the top end. Those using coke in their brazing pan can pile it up on each side of the firebox and at the back, but keeping it well clear of the tubeplate. Plenty of flux should be applied and with the blowpipe or torch going well, the flame should be directed mainly inside the firebox, moving it around so that the whole tubeplate is evenly heated and raised gradually to a dull red colour and avoiding any chance

of over-heating or burning the thin tubes, when the silver solder should "flash", forming fillets around every tube. We are sometimes advised to tackle this operation of tube fixing in two stages, but I have never found this to be necessary. The important thing is to ensure that both tube ends and tubeplate are really clean; it is not sufficient merely to rub them over with emery cloth, a few minutes in the acid pickle, followed by a wash in hot water pays dividends every time, ensuring that the solder flows really freely.



The inner firebox and tubes of a 5 in. gauge boiler ready for assembly.

After cooling, pickling and washing, the assembly should be examined carefully — there should be a bright silvery ring around every tube end *inside* the firebox; if any places look at all doubtful, they should be attended to before proceeding further.

The smokebox tubeplate is now removed and the ends of the tubes and flue heated to redness to anneal them. The assembly so far can then be tried inside the outer wrapper/barrel and if all is well, the front and side section of the foundation ring can be cut and fitted. These are made from 3/8 in. × ¼ in. copper bar, but don't forget to file deep grooves in each of the side sections opposite the point where the blow-down valves are to be fitted. A couple of 3/32 in. copper rivets will be ample to hold each section of foundation ring. These pieces of the foundation ring can be bevelled on their underside which will allow the silver solder to penetrate more easily.

The tapped bush for the attachment of the steam pipe header can now be turned up, though it should not be tapped right through at this stage, it is better to just start the threads, so that the tap can be put right though after all brazing operations have been completed. This bush is now brazed to the smokebox tubeplate, using (for preference) a silver solder or brazing alloy of somewhat higher melting point than Easyflo No. 2. The tapped holes for the solid stay and the blower tube can also be drilled, and again, partly tapped, when the tubeplate can be fitted, after a short spell in the acid pickle, pushing it down the barrel until the tubes protrude by a bare 3/32 in. Secure it by three or four gunmetal screws put in around the periphery, through the barrel and into the flange of the tubeplate. 6 BA should be strong enough.

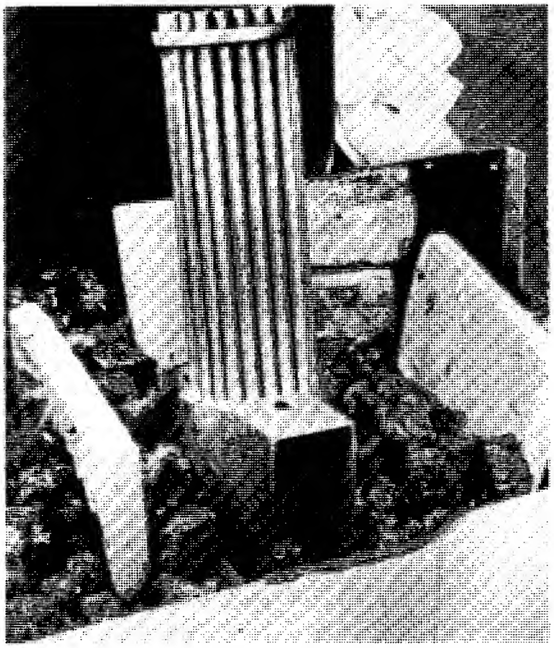
Next, lightly expand the ends of the tubes; this can be done easily with a home-made tapered drift, well polished. Repeat for the superheater flue. The smokebox tubeplate can now be silver soldered, with the boiler "up-ended", the coke can be piled up around the barrel to about 3 in. from the top. Easyflo No. 2 or Argoflo can be used here, and a good fillet built up around the flange of the tubeplate and around the tube ends.

Back to the firebox backplate now, which was temporarily removed when we were fixing the tubes. The firehole ring is turned from thick-walled copper tube, 1¾ in. outside diameter. It is fitted into a 1 5/8 in. diameter hole cut in the firebox backplate and lightly flanged over on the inside, after which it can be silver soldered before the plate is fitted into the inner firebox wrapper.

After soldering the firebox backplate in place, the backhead can be made ready. There are seven tapped bushes required here, two for the water gauge, one for the regulator spindle, one for the solid stay, one for the blower valve, one for the axle-driven feed pump clack and one for the hand pump clack. If an injector is to be fitted, one further bush will be required for its clack valve. A good plan when turning these bushes is to drill them about ¾ through, starting the thread with the tap, as mentioned earlier. After the hydraulic test has been satisfactorily completed, these bushes can be drilled right through and the tapping completed. This will avoid having to plug them for the test. All holes required for stays (19 in all) should also be drilled — No. 32 drill — at this stage. After brazing the bushes in place, the backhead can be offered up to the boiler and the rear section of foundation ring cut and fitted. No gaps must be left in the foundation ring or the silver solder will quickly find a way through. If there are any, they may be plugged with slivers of copper tapped into place.

A couple of 3/32 in. rivets will suffice to hold the rear section of the foundation ring, and about six 6 BA gunmetal screws should be enough to hold the outer wrapper of the firebox against the flange of the backhead. The firehole ring can now be lightly flanged over against the backhead. This is not difficult if the boiler is supported on something solid inside the firebox and on the back of the firehole tube.

To tackle the foundation ring, the boiler is laid on its back, and the coke is piled up on each side to within about an inch of the foundation ring, leaving the backhead clear. Some pieces of asbestos sheet or fire-



Silver soldering the tubes to the firebox. Note the coke and fire-bricks to retain the heat.

brick can be put inside the firebox to protect the crown and the tube ends, and more coke piled on top of this, taking care not to get any dust from the coke near the foundation ring. After fluxing, the whole firebox is heated as quickly as possible according to the blowpipe power available, then the flame is concentrated on one corner of the foundation ring until this glows red, when Easyflo No. 2 is fed in; the flame is then worked right round the ring, applying the Easyflo just behind the flame until the starting point is reached. As quickly as possible, up-end the boiler so that the backhead is level, apply further flux, then tackle the backhead flange and, finally, the firehole ring. As this boiler has quite a long barrel, it will be found a great convenience if the brazing pan has a hole cut in the middle large enough to allow the barrel to be put through, with the firebox above the level of the floor of the pan. This hole is normally covered with a flat piece of steel of course. After cooling and a good 15 minutes in the pickle bath, give the whole boiler a thorough washing in hot water and "Vim" and then a careful examination. If all is well, we are ready for the somewhat tedious job of staying.

For builders using propane blowpipes or paraffin blowlamps, I don't think there is anything to beat the traditional screwed stay, threaded through both plates and nutted on the inside. Fitting threaded stays to *Conway's* boiler is easier than usual as at every position where a stay is required, the two plates, external and internal, are parallel to one another. Although copper can be used, I prefer drawn gunmetal or even monel. Drawn gunmetal takes a thread much better than copper and is of course considerably stronger; on the other hand, it is better not to attempt to rivet the heads over, whereas copper, especially if previously annealed, takes to being riveted like a duck to water.

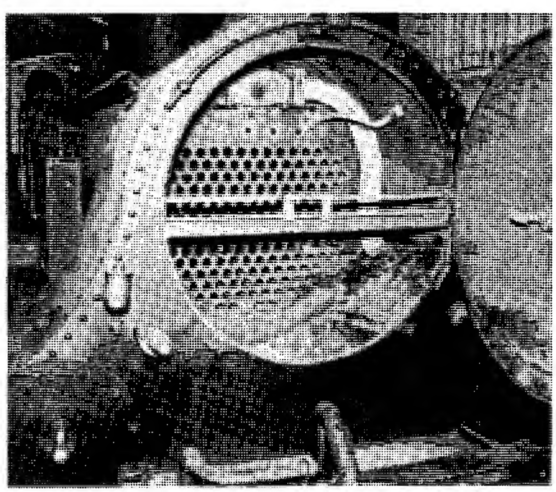
Gunmetal screws, 4 BA, can be obtained commercially, alternatively the stays can be turned in the lathe from 7/32 in. A/F gunmetal hexagon bar. The head can be partly parted off, the bar removed from the chuck and the partly made stay screwed home, the remainder of the bar being twisted off and returned to the lathe for the next stay, and so on. Ordinary 4 BA brass nuts can be used on the inside of the firebox, though brass "cap" nuts are better, being tapped "blind" they are less liable to leak.

The ¼ in. diameter solid longitudinal stay is fitted with the usual threaded nipples at each end, these being screwed 3/8 in. × 40T on the outside and tapped ¼ in. × 40T internally. They can be made from 7/16 in. or ½ in. A/F hexagon bar.

The hollow, blower, stay is made from copper tube ¼ in. outside diameter × 1/16 in. and is fitted with a union fitting at the smokebox end, while the blower valve itself is screwed home at the backhead end. Finally, two short longitudinal stays are fitted across the firebox above the barrel. These can be 5/32 in. diameter gunmetal, threaded × 40T at each end and fitted with nuts — these should be run over with Easyflo for preference, so this must be done before any firebox stays are caulked if the intention is to use one of the high-melting-point soft solders for this operation.

Next time we will deal with the hydraulic testing of the boiler, and then move on to the smokebox.

This photograph shows the smokebox of L.N.W.R. 2-2-2 No. 3020 Cornwall. *It is interesting to note that the steam chest cover is inside the smokebox itself.*



CONWAY

A free-lance narrow-gauge 0-4-0 Saddle Tank locomotive for 3½ in. gauge

by Martin Evans

Part VIII

From Page 1267

SEVERAL BUILDERS OF *Conway* have written in asking for clarification over the laminated springing, pointing out that no dimensions were given for the individual leaves, apart from the top leaves. The top two leaves, which are of spring steel, are 4 3/16 in. overall, with the oval holes for the hangers at 3 7/8 in. centres. The lengths of the remaining leaves, which are of Tufnol, will be as follows: No. 1 — 3.563 in., No. 2 — 3.305 in., No. 3 — 3.047 in., No. 4 — 2.789 in., No. 5 — 2.531 in., No. 6 — 2.273 in., No. 7 — 2.015 in., No. 8 — 1.757 in., No. 9 — 1.5 in. I have given these lengths in decimals as it was much easier to work them out that way, but of course they don't have to be worked to the nearest thou!

Another point which has arisen concerns the outside motion plate. If fitted where shown on the drawing, the top inner corner fouls the nut on the back of the spring hanger pin. This is perfectly true, but the solution is a very easy one — to file a small notch to clear the nut. This will not affect the strength of the motion plate in any way. It may be asked why the springs could not be made either longer or shorter, so as to avoid the motion plate altogether. But if made shorter, the springs would have been too hard, while if made longer, the rear end (of the leading spring) would have still been in the way of the motion plate, unless made a good ¾ in. longer, which was obviously out of the question.

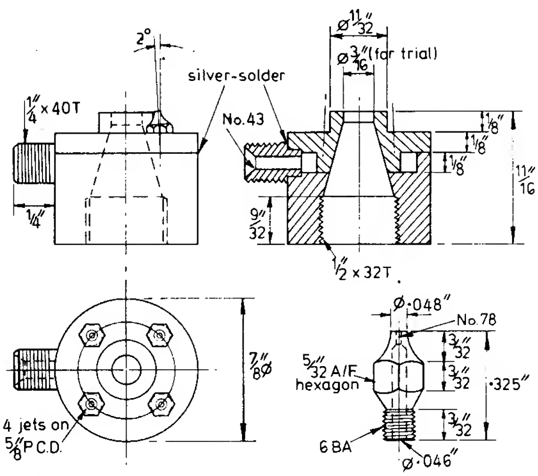
Returning now to the testing of the boiler, the first thing to do is to plug any bushes that have been drilled right through, and make up a temporary cover for the large plain bush on the top of the firebox. The inner dome can also be made up at this stage; this consists of a length of 1 3/16 in. × 16 s.w.g. brass tube with a 1 7/8 in. diameter disc 5/32 in. or 3/16 in. thick silver soldered to its base, and a thicker one, tapped 4 BA (for a bolt to hold down the outer dome) silver-soldered to the top. Ten 6 BA bolts will be required, equi-spaced around the periphery, to hold this down, the bolts being of stainless steel or bronze. Ordinary brass or steel screws are not good enough here. The cover for the firebox bush can be a plain disc around 1/8 in. thick, 1¼ in. diameter, and six 6 BA bolts will be sufficient here. Gaskets of "Hallite" or "Walkerite" or even oiled brown paper will suffice to prevent leakage.

The actual hydraulic test is simple enough. The boiler is filled with cold water, excluding any air. To one of the threaded bushes, the test pressure gauge is attached. This gauge should read to at least 250 p.s.i.; on no account should one of the small, model, gauges be used for testing. A hand pump (any size and capacity will do) is now set up in a shallow tray of cold water, with a pipe connected to one of the bushes in the boiler — one of those marked for a check valve will do nicely. If there is no air in the boiler, only a few strokes on the hand pump will send the pressure soaring, so take it slowly, watching for leaks. The final pressure should not be more than 160 p.s.i., which is twice the working pressure of 80 p.s.i., and this should be held for at least 15 minutes. Care should be taken that all the bush-plugs are sound, as leaks from any of these may easily be mistaken for leaks from the boiler itself.

Incidentally, it is a great mistake to test a copper boiler to a higher pressure than twice its working pressure. This can only strain the boiler unnecessarily and may actually weaken it.

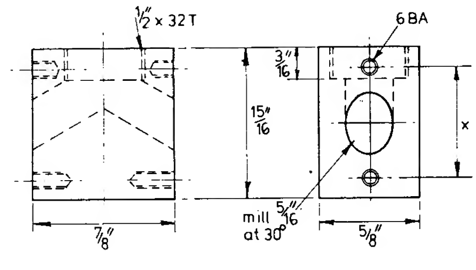
While on the subject of boiler testing, it is a very good plan for the builder to ask the Testing Committee of the nearest Model Engineering Society to carry out the initial hydraulic test, or at least to witness it, rather than do the job himself single-handed. In this way, the Society's official Test Certificate may be obtained. This is essential before the finished locomotive can be steamed on a Society track. Some builders carry out a test under steam before finally passing the boiler as fit for service. If this is done, all fittings should be in position, and the opportunity can then be taken to set the safety valve. Of course, the steam test should not be to the same upper limit as the hydraulic test. The *Model Engineer* Model Boiler testing procedure recommends that, if a steam test is carried out, it can be at 10 per cent above normal working pressure and this is what I would advise.

The smokebox of most narrow-gauge engines were of the "wrapper" type, the "drum" type, resting on a saddle, being very rare in this variety of locomotive. For *Conway,* 1/16 in. brass sheet is used, bent around a former of a diameter of 4 in. or so. We have a choice here of using hard brass or soft (annealed) brass. While the soft variety is much easier to bend, it is also much easier to end up with a series of flats and kinks! My own choice would be the hard variety, as although the metal will tend to spring out again after bending, it can be kept under control by clamping the lower, straight, part over a block of wood 4 3/8 in. wide, while the smokebox front is made and the ornamental rear ring is turned. I expect that castings will be available for both these items. The floor of the smokebox,

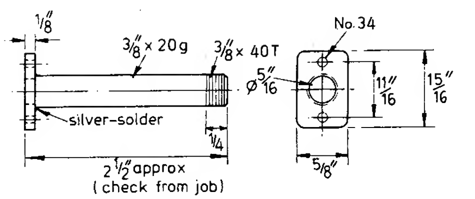


BLAST NOZZLE & BLOWER

BLOWER JET
4 off brass



EXHAUST TEE gunmetal or brass
x—locate from pipe flanges



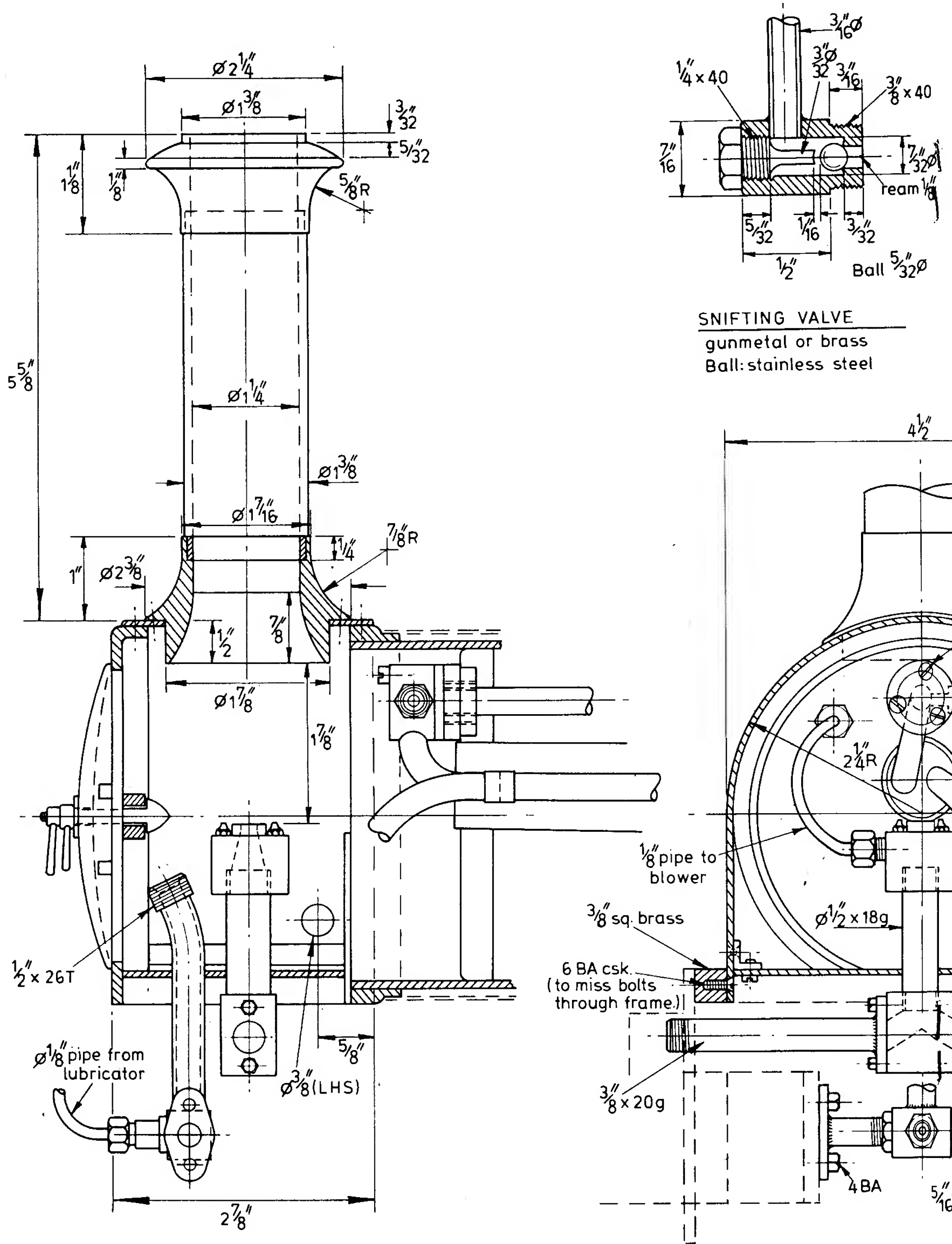
EXHAUST PIPE & FLANGE: 2 off brass

also of 1/16 in. hard brass, should be cut to size as accurately as possible, and the holes for the blast pipe and steam pipe drilled before assembly. While the location of the hole for the steam pipe is not critical it will have to be filed oval later on, that for the exhaust should be marked out and drilled as accurately as possible, so as to avoid having to bend the blast pipe later on to get it to line up with the chimney.

Clean up the front plate, turning the front true in the lathe in the area where the smokebox door is to register, drill the hinge lugs (1/16 in. diameter) and fit the brackets (made from b.m.s. of 3/16 in. × 1/16 in. section) for the crossbar. These brackets can be held to the inside of the casting by a couple of 1/16 in. copper rivets in the case of the right-hand one and by one rivet and an 8 BA screw in the case of the left-hand, as on this side one of the hinge lugs prevents a rivet being used. The ornamental rear ring is next machined, the inside being turned to a good fit over the boiler barrel. It can then be attached to the smokebox wrapper, as can the front plate, 8 BA brass countersunk screws being used at about 5/8 in. centres. We then need two triangular pieces—again 1/16 in. brass—to fill in the rear, and after the bottom plate has been put in and fixed by lengths of 5/16 in. brass angle, the smokebox will be complete ready for fitting the chimney.

Tackle the chimney next. As this is exceptionally tall, it is not worth while using a one-piece casting, so we use a length of brass tube 1 3/8 in. outside diameter × 16 s.w.g., with separate castings for the top and bottom. Note that the tube is turned at both ends to about 0.020 in. below the nominal 1 3/8 in., for a length of 1/4 in., but it will be found easier to bore the top and bottom castings first, and turn the tube to fit, rather than the other way about. As for the top and bottom castings, I recommend boring these out to final size first, then mounting them on a mandrel while the outsides are dealt with, the lower casting being finished off by filing and then polishing.

To cut a true hole in the top of the smokebox to receive the chimney, there is no better way than boring in the lathe. After drilling a small pilot hole, the smokebox is set up on the lathe cross slide (the top slide being removed) and packed up until the pilot hole is at lathe centre height. As the smokebox front will have the hinge lugs protruding, it will be easier to stand the smokebox on the rear (barrel) end. Clamp the smokebox down with care, as it will be easily distorted, and open out the hole gradually, with light cuts, finally using a sharp boring tool until the bottom part of the chimney can just be pushed in without



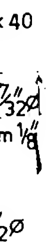
SNIFTING VALVE

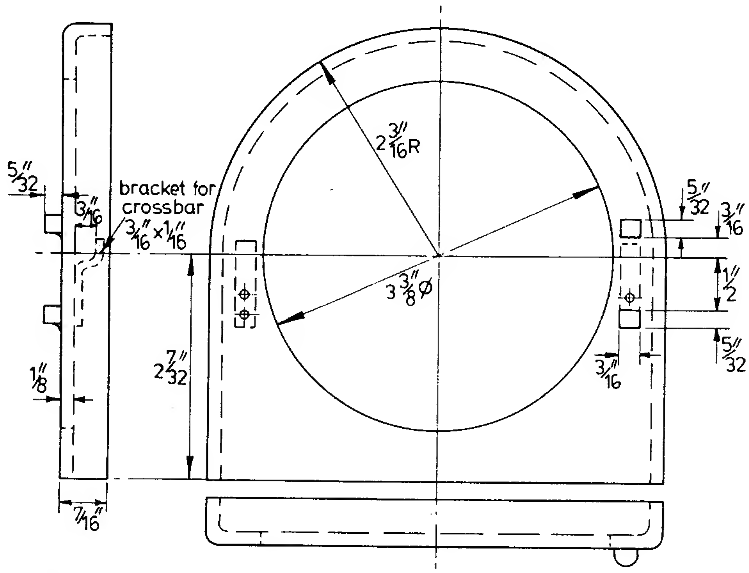
gunmetal or brass

Ball: stainless steel

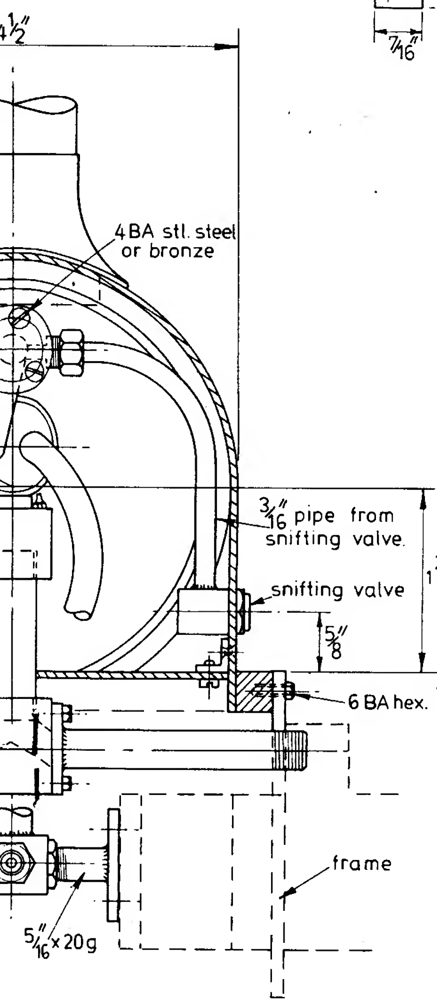
SMOKEBOX ARRANGEMENT

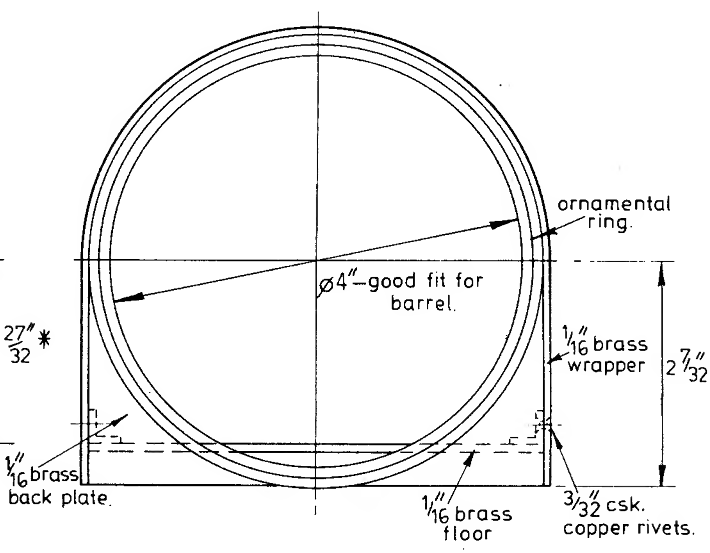
X Centre of smokebox to top edge of frames.





SMOKEBOX FRONT
gunmetal casting or built-up



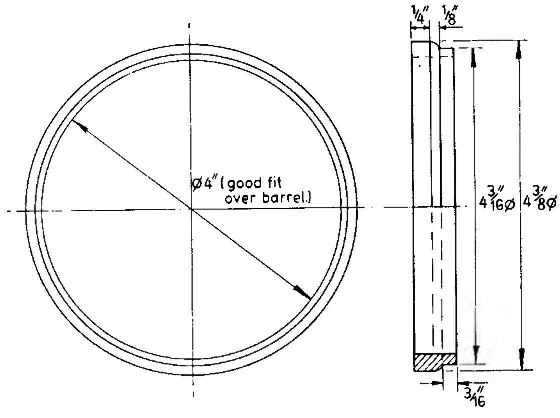


REAR VIEW OF SMOKEBOX

undue force. Having obtained a nice fit for the bottom part of the chimney, the three parts of the chimney can be united for good by silver soldering, but use only the tiniest amount of Easyflo for this, afterwards cleaning up thoroughly and polishing the top. If desired, the chimney may be fixed firmly to the smokebox by four hexagon head screws, not larger than 10 BA, for appearance's sake.

The finished smokebox is fitted to the engine frames by first screwing lengths of 3/8 in. square brass along the bottom edges, which will bring the overall width to 5¼ in. and to a nice fit between the frames. Note that the countersunk screws used to hold these square pieces must be carefully located so as to miss the bolts to be put through the holes in the frames — these will be 6 BA hexagon head — but before fixing the smokebox for good, make up the steam and exhaust connections and also try the boiler in place, and at the same time fit the angles to the sides of the firebox necessary to support the boiler at the rear end; these will be 3/8 in. × ¼ in. and 1 3/8 in. long, situated at approximately 1 11/16 in. from the bottom of the foundation ring — the exact dimension being obtained by setting the boiler horizontal.

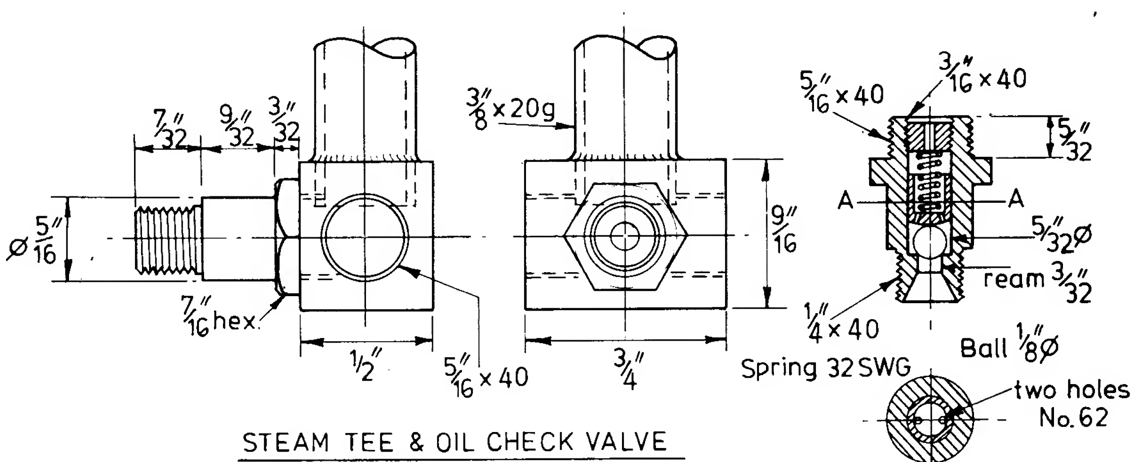
To deal with the exhaust arrangements next, the exhaust "tee" is a rectangular block of brass or gunmetal 15/16 in. high × 5/8 in. wide × 7/8 in. After machining to size, drill and tap ½ in. × 32T for the blast pipe, then cut the ways from the exhaust pipes at an angle of 30 deg. As it is not easy to drill at this angle, set the tee in the machine vice mounted on the vertical slide and cut them with a 5/16 in. slot-drill. Next, make up the two exhaust pipes, from 3/8 in. × 20 s.w.g. brass tube, threaded × 40T, to match the holes in the cylinders, then cut out and drill the flanges and silver solder them to the inner ends of the tubes. *Tip:* Make these flanges somewhat thicker than 1/8 in. to



REAR (ornamental) RING FOR SMOKEBOX
gunmetal or brass

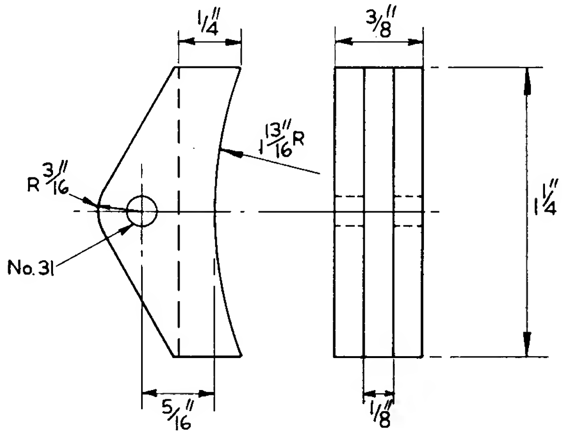
start off with, and use them to locate the tapped holes in the tee before fitting them to the tubes. The blast pipe proper is a length of ½ in. × 18 s.w.g. brass tube, threaded × 32T at each end. This may now be screwed home tightly into the tee, and the assembly tried in place between the cylinders by screwing the tubes into the cylinders as far as they will go (with a taste of Plumber's jointing or similar on the threads). Now try the tee between the flanges of the two tubes, when it will be seen how much has to be machined off the flanges to get a perfect fit. If it is found that so much has to be taken off the flanges that would leave these thinner than 1/8 in. it would be advisable to take out the tubes and take a bit off the cylinder ends.

Next, we can make up the steam connections. The steam "tee" consists of another rectangular block of brass or gunmetal, measuring 9/16 in. high × ½ in. wide × ¾ in. The steam pipe is silver soldered into the top of the tee and at its upper end a union connection



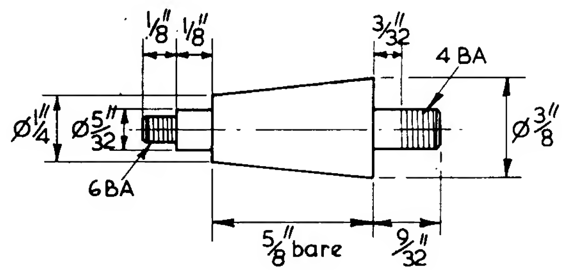
STEAM TEE & OIL CHECK VALVE
gunmetal or brass

SECTION AA



BRAKE BLOCK

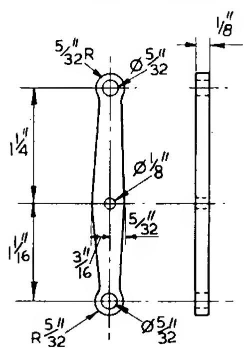
4 off b.m.s. or c.i.



BRAKE HANGER PIN

4 off b.m.s.

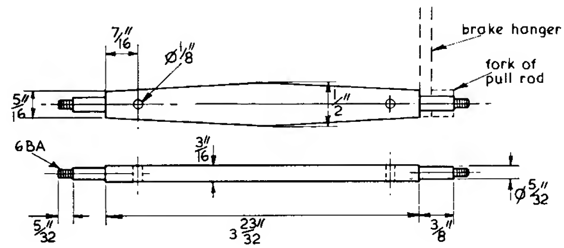
is provided, threaded ½ in. × 26T. This could be made from a short length of gunmetal silver soldered on to the tube, which may be either brass or copper, and is again 3/8 in. outside diameter × 20 s.w.g. An alternative method is to use solid gunmetal rod, ½ in. diameter, turning this down to 3/8 in. diameter and drilling right through about 19/64 in. diameter. In either case, of course, the bending must be done afterwards, although the angle of bend need not be quite so great as shown in my drawing; the bend is only done to give plenty of room to get the union nut on, when connecting up from the superheater, the blast pipe being rather close. The steam tee is now cross-drilled 9/32 in. diameter and tapped right through 5/16 in. × 40T for the oil check valve.



BRAKE HANGER.

4 off b.m.s.

The oil check valve is made from 7/16 in. A/F hexagon brass. Turn the outer end first, threading the end ¼ in. × 40T and drilling and reaming right through 3/32 in. diameter. Open out the extreme end with a 60 deg. countersink, then reverse in the chuck, holding by the 5/16 in. diameter; turn the other end to 5/16 in. diameter thread 40T, open out the 3/32 in. diameter to 5/32 in. diameter and form the seating for the 1/8 in. ball with a D-bit, finally tap 3/16 in. × 40T not deeper than 5/32 in. The spring cup, which keeps the ball on its seating, should be quite an easy fit in the 5/32 in. diameter, and if made hollow as shown, will



TRAILING BRAKE BEAM: 1 off b.m.s

LEADING BRAKE BEAM: 1 off b.m.s.

(other dimensions as trailing beam.)

Description of Brake Gear next month.

enable a longer spring to be used. The cup is drilled at the bottom to allow the oil to pass, while the hollow 3/16 in. × 40T plug keeps the spring in position.

The completed oil check valve should be screwed home with an application of plumber's jointing or red Hermetite on the threads to ensure steam tightness. The completed steam tee is fitted between the steam chests with short lengths of 5/16 in. × 20 s.w.g. brass tube, with flanges silver soldered on, in a similar manner to the exhaust. To get an exact fit beween the two steam chest covers, these flanges may be skimmed down as required.

The hole in the floor of the smokebox will now have to be filed large enough to allow the smokebox to be lowered into position with the steam tee and pipes (and the exhaust tee and pipes) in position. The blast pipe is now fitted up with the blower shown, this having four separate jets as recommended recently by our worthy Editor. A snifting valve is a useful fitting to any locomotive, especially one fitted with a firebox type of superheater (as *Conway* will be in due course) so a 3/8 in. diameter hole should be drilled in the left hand side of the smokebox, as shown. *Continued*

CONWAY

A free-lance narrow-gauge saddle tank locomotive

by Martin Evans

Part IX

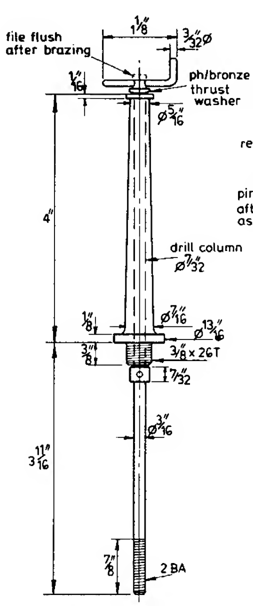
From Page 1389

I WAS INTERESTED in the remarks by Brian Hughes in the October 17th issue where he takes me to task for providing two footsteps to enable the imaginary driver to mount the footplates of *Conway.* Brian is much more knowledgeable on the narrow-gauge than I am, and he is of course quite right when he says that a flight of steps would be quite unnecessary in the type of locomotive depicted by *Conway.* I think I put them in by sheer force of habit, having dealt with mainly 4 ft. 8½ in. engines up to now. However, I see from my collection of locomotive photographs that many narrow-gauge 0-4-0 tank engines had *one* footstep, so builders can omit the upper step. As to the height of the cab roof, frankly I set it at the height I thought looked nice, without worrying too much about drivers' heads, though as I mentioned in an earlier article, I was thinking of a locomotive to 1 1/16 in. scale, but to run on 3½ in. gauge rather than the more usual 5 in.

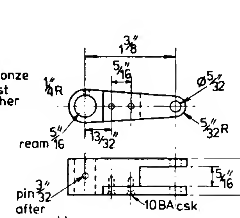
Whether one should expect a free-lance model to be reasonably representative of full-size practice is a matter of opinion, but I hope that Brian does not really regard *Conway* as a caricature!

Before I continue with the construction, I must apologise for an error in the dimensions of the boiler. The length of the boiler barrel must be 14¼ in., not 14 in. as on the drawing, page 1130/1. This means that the smokebox tubeplate is set in 1½ in. from the outer end of the barrel, not 1¼ in., so that the lengths of the tubes and flue are unaltered. *This is important,* as if the barrel is made only 14 in. long, the throat-plate would foul the rear coupled wheels, unless the smokebox was pushed further to the rear, or made ¼ in. longer, and that would entail several problems.

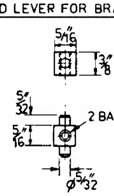
I have not so far said anything about brakes for *Conway;* to keep things as simple as possible, I am showing a simple manual brake, operated by the usual vertical column and screw, which is quite easy to make. The brake blocks and hangers are much the same as on any conventional ¾ in. scale locomotive, but there are no cross-beams, the 1/8 in. dia. pull rods being attached to the leading hangers via a simple forked member, while a special pin and coupling is used attached to the driving hanger. The brake shaft is carried in gunmetal bearings which are made a press fit in the ½ in. dia. holes in the frames. This shaft is extended outwards on the righthand side of the locomotive to carry the forked lever which is raised or lowered by the brake standard. The nut for this is best turned from the solid, as it is not easy to fit the very short pins that are required on each side of the nut and ensure that they won't work loose in service. As the nut and pins are integral, it is necessary to make one side of the forked lever removable, but there is no great difficulty about that.



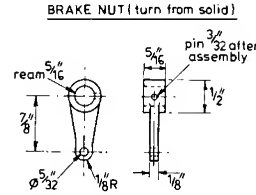
BRAKE COLUMN & SCREW



FORKED LEVER FOR BRAKE COLUMN

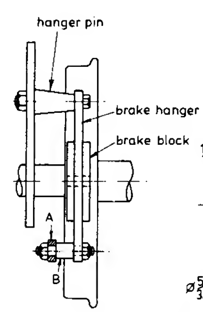


BRAKE NUT (turn from solid)

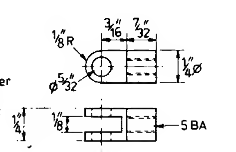


LEVER FOR BRAKE SHAFT

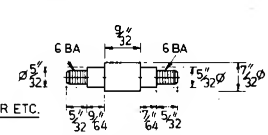
2 off b m s



END VIEW OF BRAKE HANGER ETC.

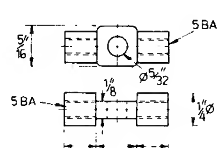


FORK FOR LEADING BRAKE HANGER



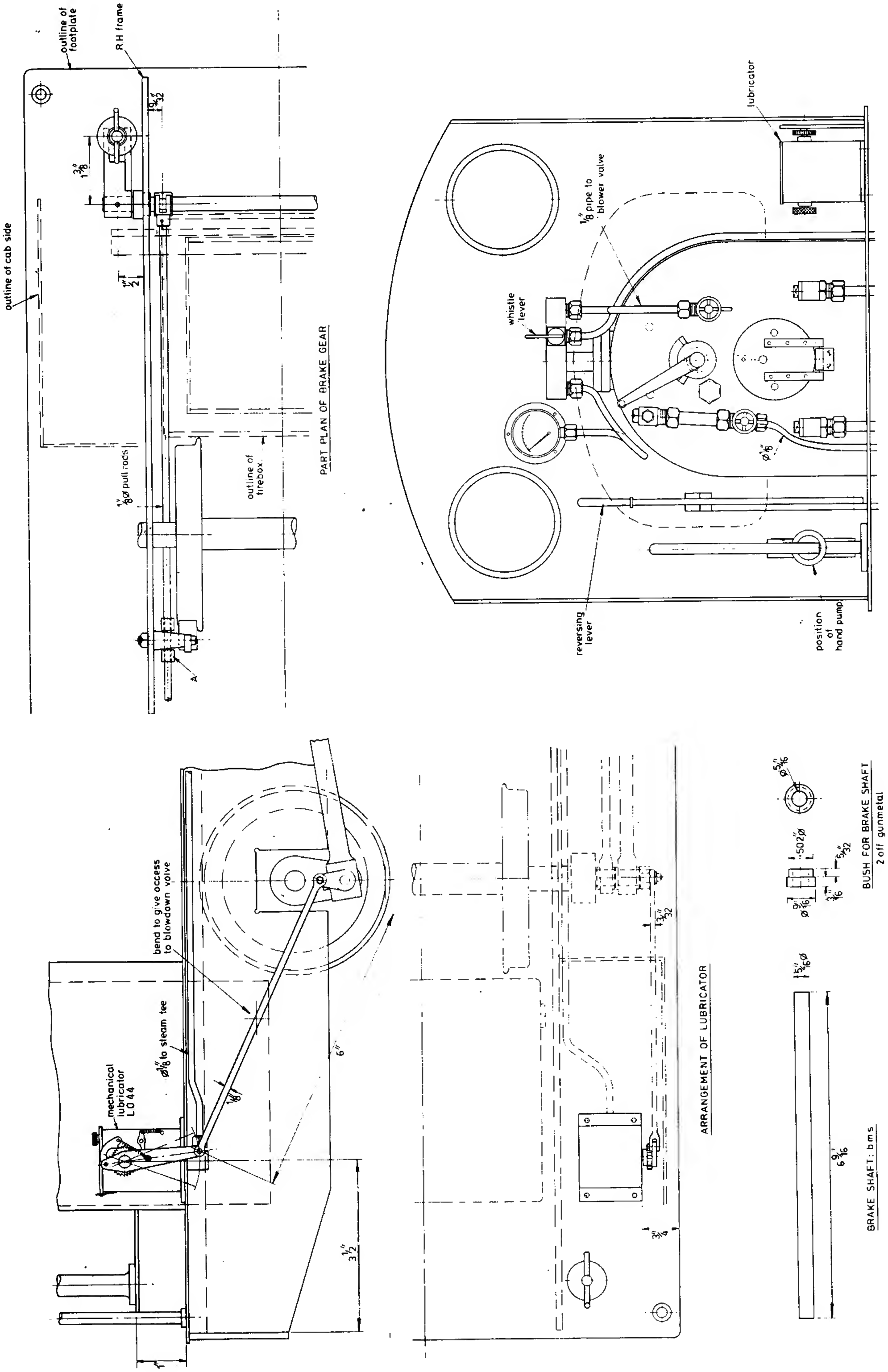
PIN (B) FOR DRIVING BRAKE HANGER

2 off sil steel or b m s



COUPLING (A) FOR DRIVING BRAKE HANGER

2 off b m s



PART PLAN OF BRAKE GEAR

ARRANGEMENT OF LUBRICATOR

BUSH FOR BRAKE SHAFT

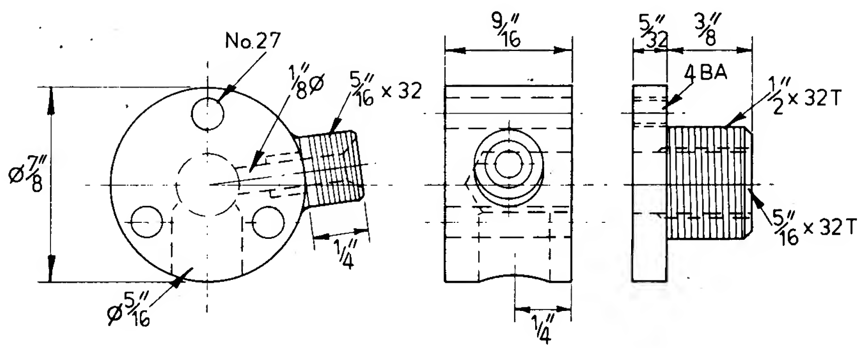
BRAKE SHAFT: bms

The brake column could be made from gunmetal, mild steel or even brass, but if not made from gunmetal, the "stop" collar on the spindle should be in gunmetal or phosphor bronze, while a gunmetal thrust washer is a useful addition at the top end, to give smooth working. The spindle is threaded 2 BA where it passes through the nut and could be silver-steel, b.m.s. or stainless steel, as preferred. The completed column is bolted, via the 3/8 in. × 26T thread, to the footplate proper, which is 15/16 in. above the running board level. This will be shown in the next article.

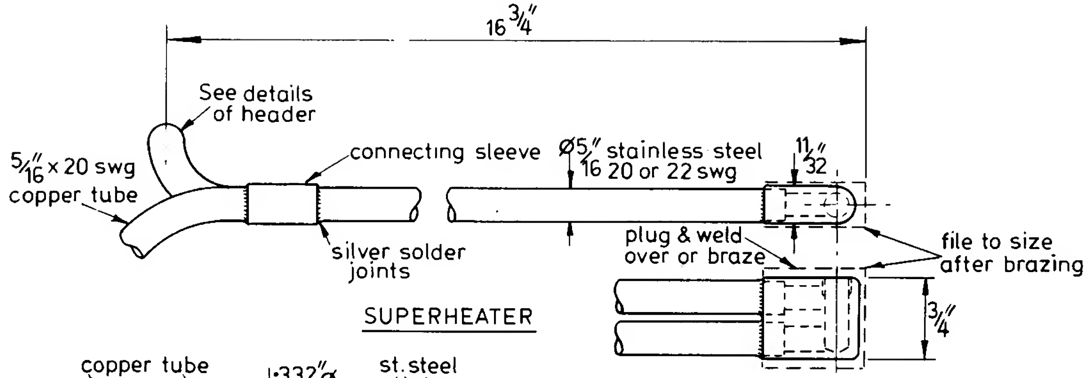
It will be noticed that there is no "return spring", to pull the brake blocks away from the wheel treads when the brake is released. However, I don't think this will be necessary as the various components should be stiff enough to enable the column to push as well as pull. One final point:- the rear part of the pull rod has to pass through the rear angle which I described as a "safety angle" (page 607). I deliberately did not show a clearance hole in this, as the exact position is best determined on the job. But it should be the work of a few minutes to remove this angle and drill and file a suitable oval hole on each side, to give the necessary working clearance.

Lubrication

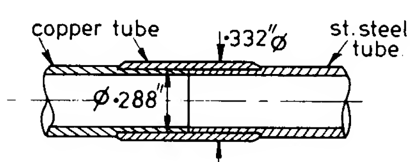
As I mentioned in the May 16th article, I came to the conclusion that to avoid the unsightly situation of a huge (by full-size standards) mechanical lubricator mounted on the running board, the lubricator might be fitted in the cab, and driven by a little return crank fitted to the end of the right-hand driving crankpin. As it turned out, there was plenty of room between the firebox and the cab side, and the coupling up of the return crank to the lubricator driving lever was simple, involving a long rod passing through a slot in the footplate. The only slight snag to this was that said rod makes access to the boiler blow-down valve on the



STEAM PIPE HEADER



SUPERHEATER



DETAILS OF CONNECTING SLEEVE

2 off

right-hand side of the firebox rather difficult. Fortunately, however, the blow-down valve is considerably further in, towards the centre of the engine, so a small double bend in the lubricator driving rod should take care of things.

The 1/8 in. dia. oil delivery pipe from the lubricator can run forward just underneath the running board and close to the frame, then dropping down to clear the outside motion plate, finally turning inwards to couple up to the oil check valve on the steam "tee".

Some builders may think that placing the lubricator in the cab not very far away from the fire-door may result in coal dust getting into the oil. This however could be effectively prevented if a hinged cover was fitted, to completely cover the lubricator and its driving gear, the hinge being on the left-hand side (looking towards the front of the locomotive). The great length of delivery pipe involved with this arrangement may be regarded as a drawback, but once this has been filled (which can be done manually by turning the lubricator spindle) there should be no problem.

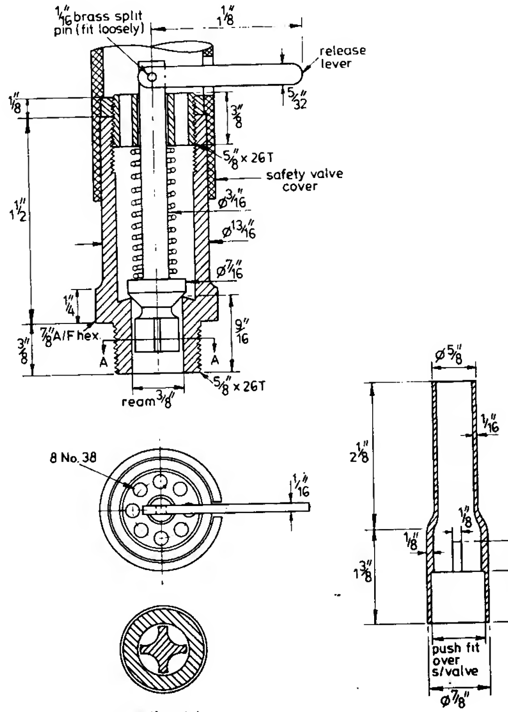
Superheater

The superheater is of the firebox radiant type, but as the boiler barrel is unavoidably long, I fear that no great degree of superheating will be obtained. In full-size practice, it was generally easier to obtain a high degree of superheat in short-barrel boilers than in boilers with long barrels, and I believe that this applies equally to our model boilers.

To avoid the difficulty of bending stainless steel tube, the curved part of the superheater from the "wet header" to the flue is made from copper tube, also that part from the flue to the connection to the cylinders, so that stainless steel is only used for the straight parts of the superheater, connection being made by sleeves, turned from thick-walled copper tube (3/8 in. × 16 s.w.g. copper tube is a commercial size I believe). Note that to make a neat and "streamlined" job of the connection, the ends of both the stainless steel tube and the copper tube are turned down slightly, and the sleeve is reduced as much as safety allows and its ends are chamfered, after which the joint is brazed. The bends in the copper parts can be put in afterwards, as they will be softened by the brazing operation.

Boiler Fittings

To deal with some of the boiler fittings now, the single safety valve is of conventional design, but as it is sited inside the cab, it is necessary to fit a tubular cover over it, to direct the steam away from the driver. To enable the driver to check whether the valve is releasing properly, a very simple release lever is fitted to the top of the spring pin, and passes through a slot in the cover. The lever, of 1/16 in. thickness, is loosely attached to the spring pin by a brass split pin, I say loosely deliberately because if made at all tight it



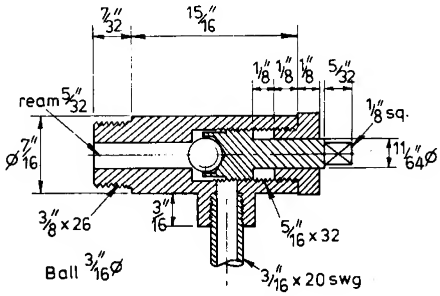
Section AA

SAFETY VALVE

1 off gunmetal or ph/bronze valve monel or stainless stl.

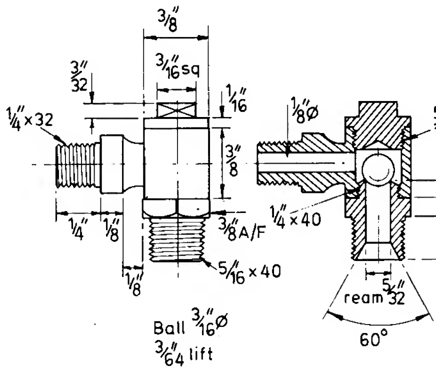
would interfere with the action of the valve, and that might be dangerous. Note also that the slot in the cover must be fairly deep (3/8 in. should be sufficient) otherwise it may prove impossible to insert the release lever through it, as the cover is lowered into position. The cover, incidentally, need not be a tight fit over the safety valve as it can be held firmly, if thought desirable, by a little bracket attached to the cab roof; or it may just be made a good fit in the hole in the cab roof.

The valve itself is best made from a different metal to the body of the fitting, an ideal combination would be stainless steel for the valve and monel metal for the body; almost as good would be a stainless steel valve with the body in gunmetal or phosphor bronze. The valve can be turned from 7/16 in. dia. stock, and after turning the coned part to as fine a finish as possible, it should be very lightly ground or lapped in. (Whistons of New Mills stock various polishing compounds — usual disclaimer). The spring pin, if made integral with the valve, provides a useful means of holding the valve while the "wings" at the bottom end are milled. To mill the four half-round slots to form the "wings", we need a short piece of 3/8 in. square steel. This is drilled a good fit for the spring pin, and a clamping screw, about 4 BA, put in at right angles. This "holder" can then be clamped in the machine vice



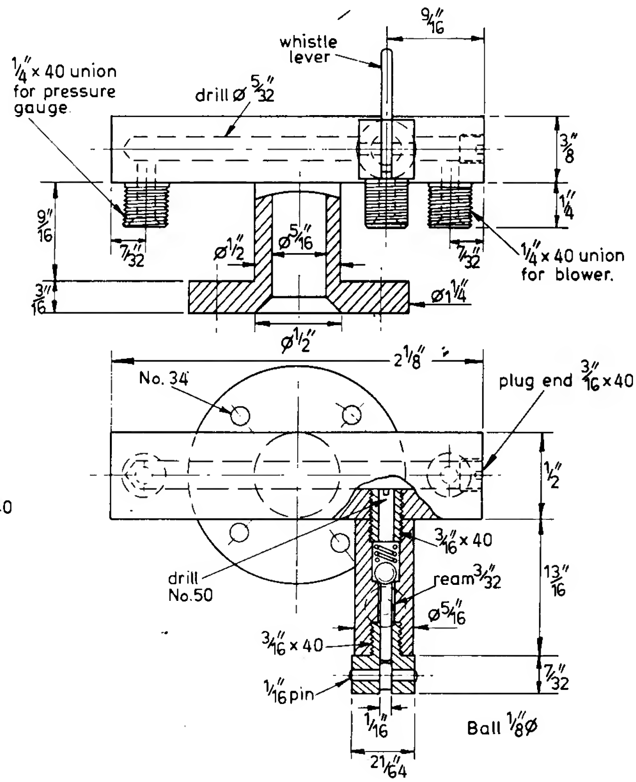
BLOWDOWN VALVE

2 off, gunmetal or ph/bronze or monel stainless steel ball.



CHECK VALVE

2 off gunmetal or brass

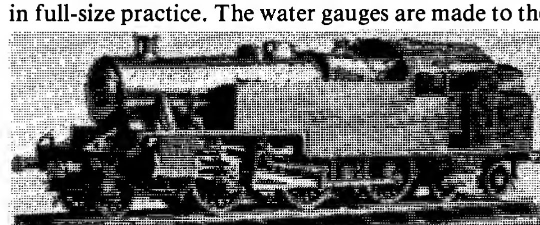


MANIFOLD

attached to the vertical-slide and brought up to a small end mill in the 3-jaw chuck or collet. By turning the holder through 90 deg. for each cut, nice neat "wings" will be produced. Although it is possible to calculate the size and strength of spring required for the safety valve, this is only likely to give us a rough guide as amateur-made springs, wound from stainless steel or hard phosphor bronze wire, can vary greatly in strength or "springiness", so I think the best way is trial and error, using the large pressure gauge to set the valve at the desired blow-off point. (80 p.s.i.)

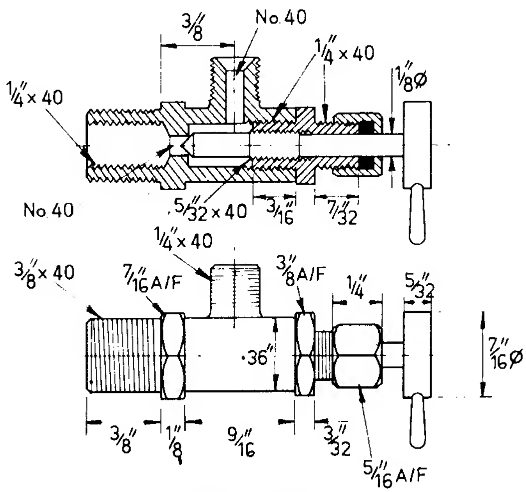
The manifold or turret is a fairly simple one this time, having branches for the pressure gauge, blower steam and whistle. My previous designs of turret have been of the screw-in type, the bush in the boiler being threaded to suit. But this has sometimes proved a problem in finding sufficient clearance to enable the fitting to be turned. So this time I am showing a flange fitted turret, held to the large bush already described by four 6 BA screws (stainless steel or bronze screws!). These have been arranged so that they can be reached comfortably by screwdriver from above. A "Hallite" or "Walkerite" gasket can be used to ensure steam-tightness.

My picture shows a very fine ¾ in. scale L.M.S. 2-6-4 tank locomotive built by South African reader Nick Popich. This engine was based on my *Jubilee* design of 1958, but with many refinements and additions. Needle-roller bearings are fitted to the axles which are heat-treated. Close-to-scale crossheads, slide bars and valve spindle guides are fitted, with built-up motion plates. All rods are made from stainless steel. The boiler is all-copper with all joints brazed or silver-soldered and is tested to 200 p.s.i. The water feed pipes are fitted under the boiler cleading as in full-size practice. The water gauges are made to the



Dewrance design, and the injector was made by Mr. Popich and functions perfectly. Mr. Popich writes to say that a constructional series in *Model Engineer* on a South African prototype would be very much welcomed in South Africa. If our worthy Editor gives his permission, perhaps this might be considered before very long! The photograph was taken by Pieter Roos of Pretoria. Oh! I almost forgot! The engine, after painting and lettering, took the Gold Medal at the recent Rand Show. *Continued*

1/16 in. or 16 s.w.g. copper tube) to the required length and threading both ends 40T, screw it into the blower valve with a touch of plumber's jointing or similar paste on the threads, then obtain a short piece of steel rod of such a diameter that it is a push fit into the front end of the stay tube. Turn this to a sharp point and push it into the stay tube until about an inch is protruding. Now insert the stay through tapped bush in the backhead and "go fishing" for it through the dome bush, using a bit of thin wire bent into a hook. It should not take long before the point of the rod in the end of the stay "finds" its proper place in the tubeplate, and the blower valve can then be



BLOWER VALVE

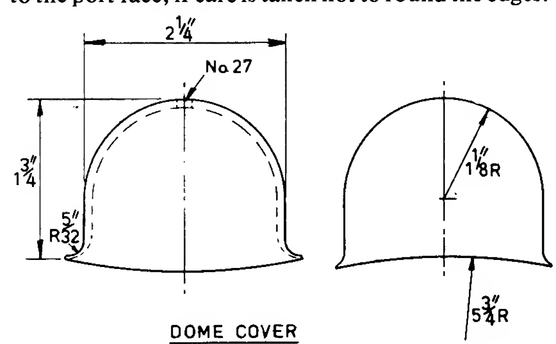
Body, brass or gunmetal
Spindle, monel or stainless stl.

screwed right home. The double-ended union fitting for the blower itself is now screwed home, engaging the external threads on the stay tube and the internal threads in the tubeplate simultaneously. But if the threads don't engage freely, due to a slight "pitch error", don't attempt to force it, but take the blower valve out again and put a very thin washer on it and try again. A bit of trial and error here will eventually allow the union fitting to be screwed home without straining the threads. For the connection to the blast pipe top, the 1/8 in. or 5/32 in. copper tube should be bent well clear of the tubes so that tube sweeping is interfered with as little as possible.

Regulator

I have been reminded that I have so far said nothing about the regulator, which is really rather remiss of me as this fitting is probably one of the most important on the boiler, or indeed on the whole locomotive! At first, I was tempted to specify one of the screw-down type, which is certainly the easiest and quickest to make; but many locomotive builders dislike this variety, on the grounds that too much movement of the handle is needed to get a decent opening to steam. There is also the possibility that the valve will jam shut if precautions are not taken. The "disc-in-a-tube" is not a good design either, as it is very liable to leak steam due to foreign bodies or scale getting between the valve and the port face. The L.M.S. slide type would not fit conveniently in the very tall dome on *Conway*, and a poppet valve type would be very much out of place on a narrow-gauge tank. So I was left with the Stroudley type, which is ideal for very tall domes.

I expect our usual advertisers will be able to supply a gunmetal casting for the body of the Stroudley regulator. This will need careful cleaning up on all faces, the port face being turned to as good a finish as possible (holding the casting in the 4-jaw for this with a suitable balance-weight to prevent vibration) and the No. 39 hole drilled (for later tapping 5 BA). A light touch with fine grade emery cloth may also be applied to the port face, if care is taken not to round the edges.



DOME COVER

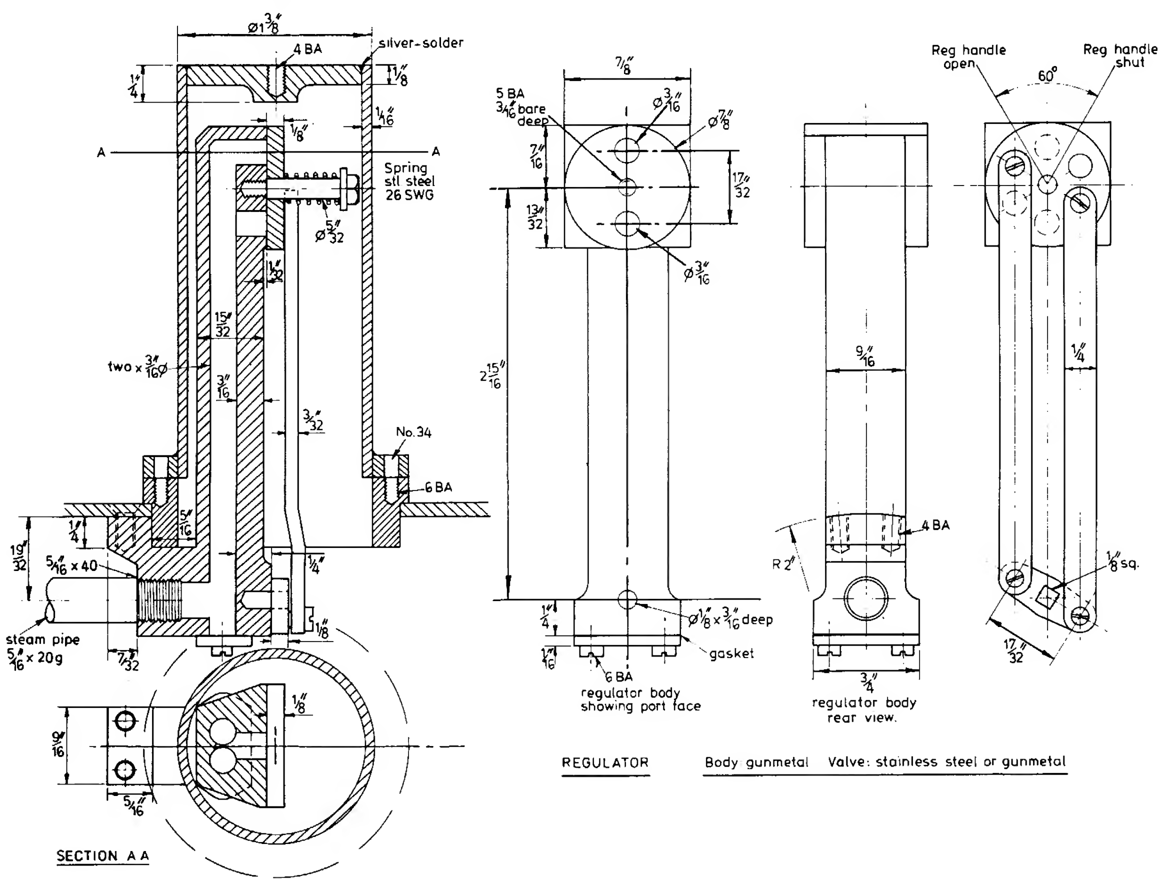
The bottom face of the casting is also better machined in the lathe, as this has to be made steam-tight by a cover plate and gasket after assembly. We now have to drill (from the bottom face) two 3/16 in. dia. holes as close together as possible, and as these holes have to be no less than 3½ in. long, great care will have to be taken that they don't run out of true, also that the drill doesn't go in too far and break out at the top! (If this calamity does happen, don't scrap the casting, as the hole could be plugged.) How to prevent the drill running out? I would suggest that the lathe be used, holding the casting in the 4-jaw again, and lining up each hole in turn by the use of a "wobbler" (no workshop should be without one of these simple but indispensable gadgets). Put a drill slightly under 3/16 in. dia. (say No. 14) in the tailstock chuck with not too much overhang (after the usual centre-drilling of course) and run the lathe as fast as possible short of vibration. Feed in very gingerly, and withdraw the drill frequently to clear the swarf; also when bringing the drill in again after each withdrawal, do so very gently — any sudden jerk may put the drill tip off centre. Having gone as far in as possible with the first position of the drill in the tailstock chuck, pull the drill further out, and drill to about 2¼ in. deep. To finish the holes, a standard "long" 3/16 in. drill will be

required. I am fortunate enough to have one of these, which has come in very useful in the past when drilling cylinders for attachment to frames; but it is hardly worth buying one just for this job. An alternative is to turn down the shank of a normal length drill, to say 1/8 in. dia. and fit an extension. Use a length of mild steel for this slightly over 3/16 in. dia. and, after pressing this over the reduced part of the drill, set the drill up dead true in the lathe and turn down to a thou or two under 3/16 in., after which the drilling job can be completed.

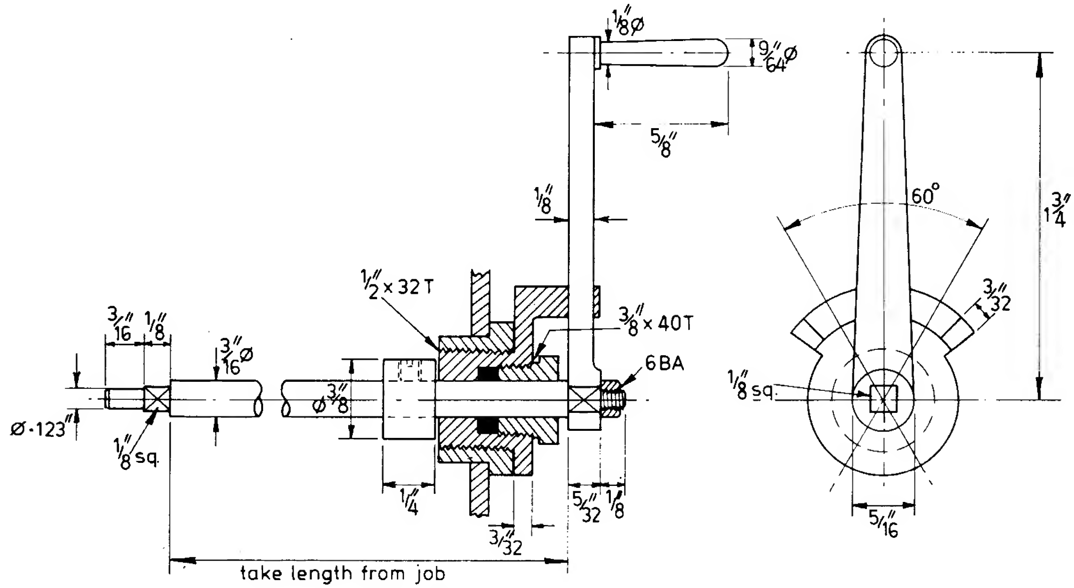
The drilling of the two ports, the hole to take the end of the operating spindle and the tapped hole to receive the end of the main steam pipe should not present any difficulties. To make the rotating valve, use monel metal or stainless steel and this can be finished by lapping, after drilling the holes plus the two tapped holes for the driving pins. The central hole in the valve may be very lightly countersunk on the port face side with advantage. Make sure that the central pin, on which the valve rotates, stands out quite square and that the valve is quite free on it. For the two operating levers, brass strip ¼ in. × 3/32 in. is used, while the pins may be turned from gunmetal or stainless steel. The operating crank, at the bottom of the regulator, is cut from any stainless metal (except ali!) 1/8 in. thick, and has a 1/8 in. square hole to take the spindle, which is turned and filed from 3/16 in. stainless.

Some very careful filing will be required to get the regulator body to fit nice and firm against the dome bush and the underside of the boiler barrel. That part which butts up against the barrel, incidentally, is best made to a radius slightly *more* than the inside radius of the barrel — this will prevent the fitting from rocking, when the 4 BA screws are tightened up.

I hope that a gunmetal casting will also be available for the backhead stuffing box, with its "stops", although it would not be very difficult to build this up by silver-soldering. The regulator handle also fits on a 1/8 in. square, filed on the outer end of the operating spindle. To keep the spindle properly engaged with the square hole in the lower crank, a little collar is fitted, against the back of the stuffing box fitting, as shown. The inner dome cover can be made from a length of 1 3/8 in. brass tube, 1/16 in. thick wall, the flange and the top plate being silver-soldered to it. Eight 6 BA bronze screws will be required to hold the dome cover

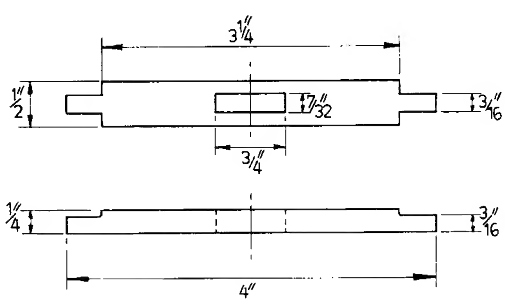


REGULATOR Body gunmetal Valve: stainless steel or gunmetal

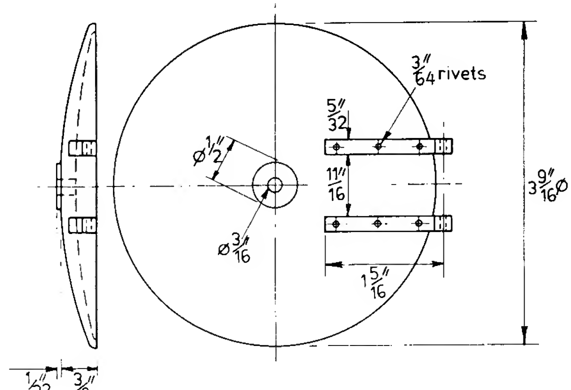


REGULATOR HANDLE & SPINDLE

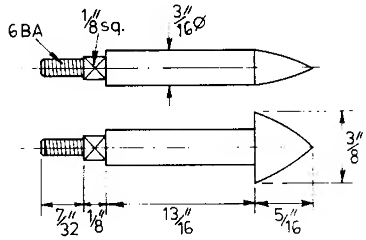
Spindle : stainless steel
Handle : stainless or b.m.s.
Stuffing box & gland : gunmetal



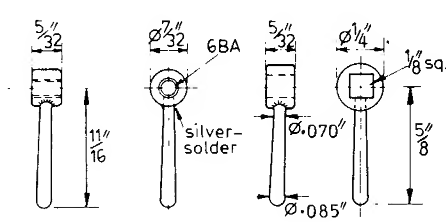
CROSSBAR : b.m.s



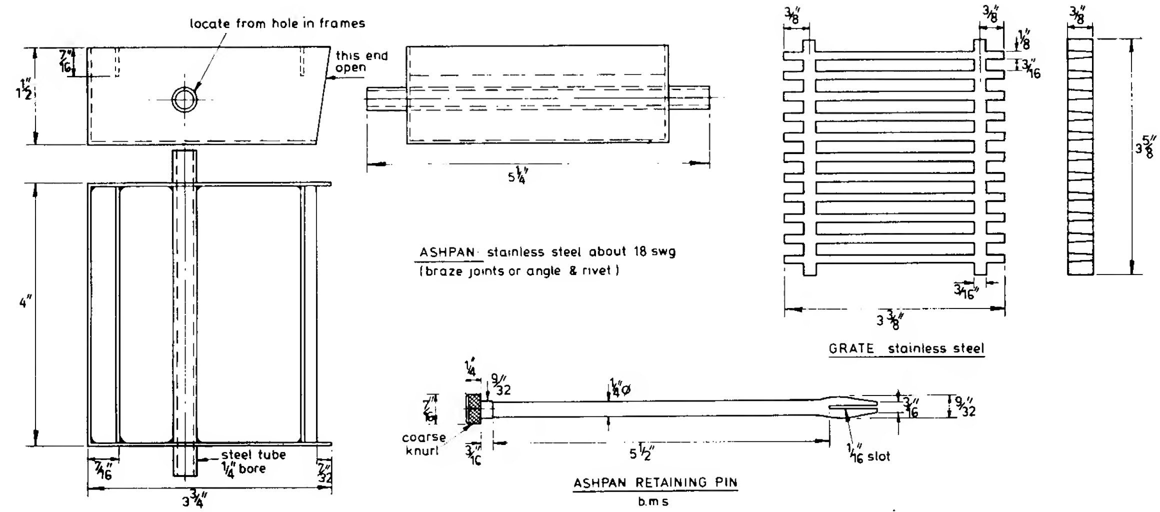
SMOKEBOX DOOR
gunmetal casting or from brass blank



DART for SMOKEBOX DOOR
stainless or b.m.s.



SMOKEBOX DOOR HANDLES
stainless or b.m.s



ASHPAN stainless steel about 18 swg (braze joints or angle & rivet)

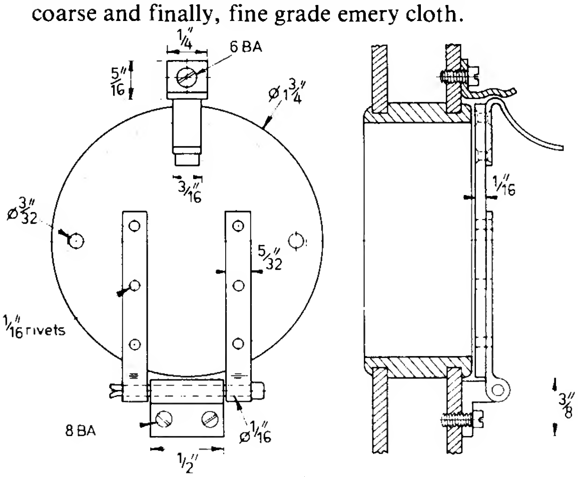
GRATE stainless steel

ASHPAN RETAINING PIN b.m.s

down, with the usual gasket. The outer dome cover will be held down by a single 4 BA bolt, into a "blind" tapped hole in the top plate.

Smokebox Door

Smokebox doors are sometimes supplied as gunmetal castings with the hinges cast on. The snag of this is that it is impossible to turn the outside; so separate hinges are to be preferred. They can be filed up from brass or steel about 5/32 in. square and rivetted on, using 3/64 in. brass rivets. But before doing this, the casting will have to be turned, tackling the register first, to ensure that the door clamps air-tight against the smokebox front. A chucking spigot is usually provided for this operation, but to turn the outside, it is best to drill a small hole (centrally) and fit a spigot on the inside, made from a short length of brass rod about ½ in. dia. Turn this down to a tight fit in the hole and soft-solder it as well, then the outside can be turned without trouble, finishing off with coarse and finally, fine grade emery cloth.



FIREDOOR

Door & hinges b.m.s. or stainless steel
Handle & spring catch — stainless stl. or hard ph/bronze
Screws — gunmetal

Grate and Ashpan

The grate is of very simple shape, and can be made up from stainless steel strips filed taper in the usual way in between the spacers, which should be 3/16 in. thick. Alternately one of Norman Spink's "ready-made" stainless grates will do fine. Note that the grate fits up inside the firebox without any positive fixing, being held there by "ribs" fixed across the ashpan. This makes it a very quick and easy job to remove the grate in emergency. (What's that? Yes, I know we shouldn't let our water level get below the bottom nut, but that CAN happen even in the best circles!)

The ashpan is built up from stainless steel about 18 s.w.g., with all joints brazed, or angles and rivets can be used if preferred. To ensure that the retaining pin holds the ashpan hard up against the underside of the firebox, leave the location of the steel tube shown to the last; clamp the ashpan in position and run a drill through the appropriate hole in the frame, keeping it as near horizontal as possible, to make a countersink on the side of the ashpan. The ashpan can then be removed and drilled for the tube, which should be brazed in place. If the ends of the tubes are belled out a little, this will enable the retaining pin to "find" it more easily.

Firedoor

My drawing shows the once-despised drop-type firedoor. This type of door is quick and easy to make, and as long as the hinge is kept clear of coal dust, will not jam open and will remain shut when required. The door itself is best made from mild or stainless steel as a brass door gets uncomfortably hot in service. The spring catch can be made from a piece of clock spring, which will have to be annealed for bending of course and then re-hardened and tempered. Alternately, use hard phosphor-bronze. All the screws should be of bronze of gunmetal and given the usual dose of plumber's jointing or similar before screwing home into the backhead.

Continued

CONWAY
A free-lance narrow-gauge 0-4-0 saddle tank locomotive for 3½ in. gauge
by Martin Evans

Part XI (Conclusion)

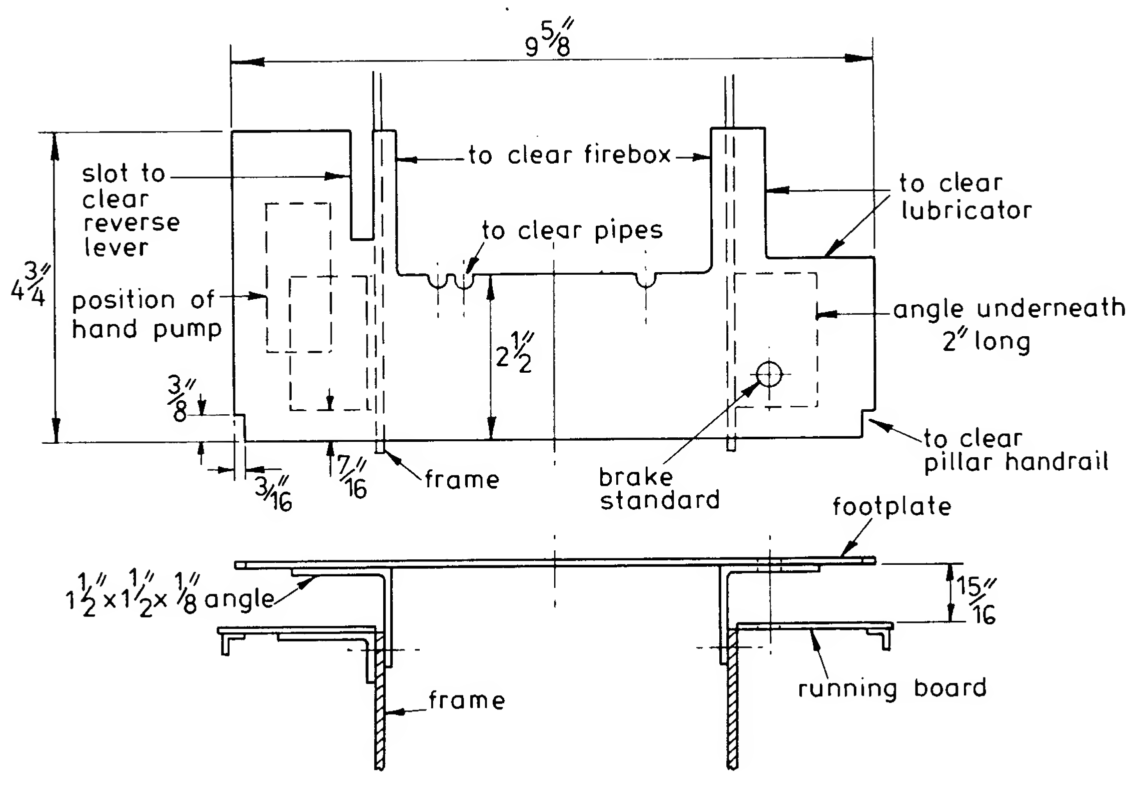
From Page 94

Lagging and Cleading

The lagging and cleading on this locomotive is very simple, and I don't think there is any need for a drawing. The barrel is 4 in. dia. and all we need is something to bring this up to an outside dia. of 4¼ in. Whatever metal is used for the cleading, it will be almost entirely hidden by the saddle tank, so brass, steel or aluminium about 26 s.w.g. will do the job, plus lagging of a thickness slightly less than 3/32 in. (to allow for the thickness of the boiler bands). "Hallite" sheet material would be satisfactory, and if the boiler bands are not thicker than 22 s.w.g., 1/16 in. thick Hallite should bring the overall dia. to not more than 4¼ in. It is worth making a thin cardboard pattern for the cleading; this will enable the hole required to clear the dome to be accurately located and may save spoiling the metal to be used. Three boiler bands about ¼ in. wide should be ample to hold the cleading in place. The firebox may also be lagged if required, but unless the lagging material is about ¼ in. thick, I don't think there will be much advantage as far as heat losses are concerned.

Saddle Tank

Brass sheet about 20 s.w.g. should be about right for the saddle tank, with 1/16 in. brass for the ends. It is

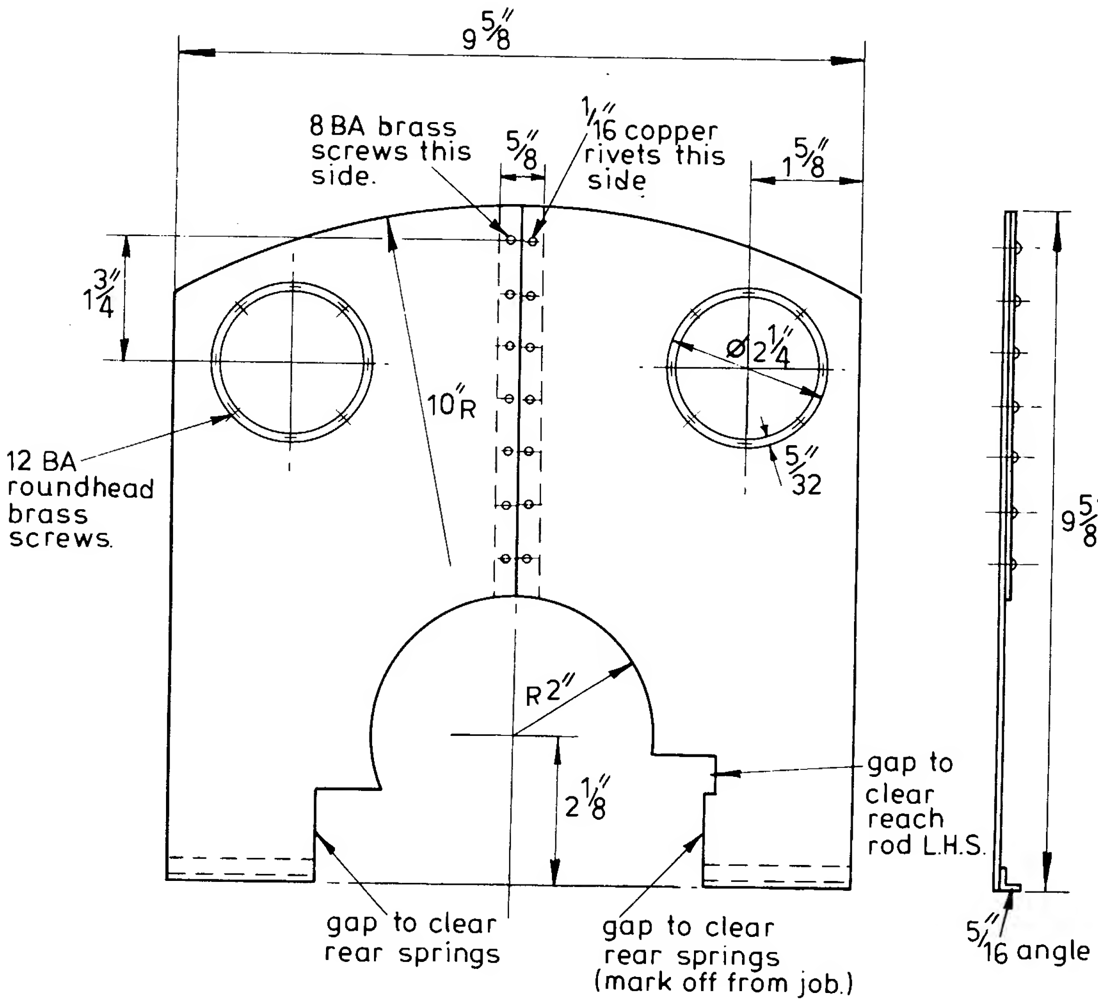


FOOTPLATE ASSEMBLY

1/16" steel

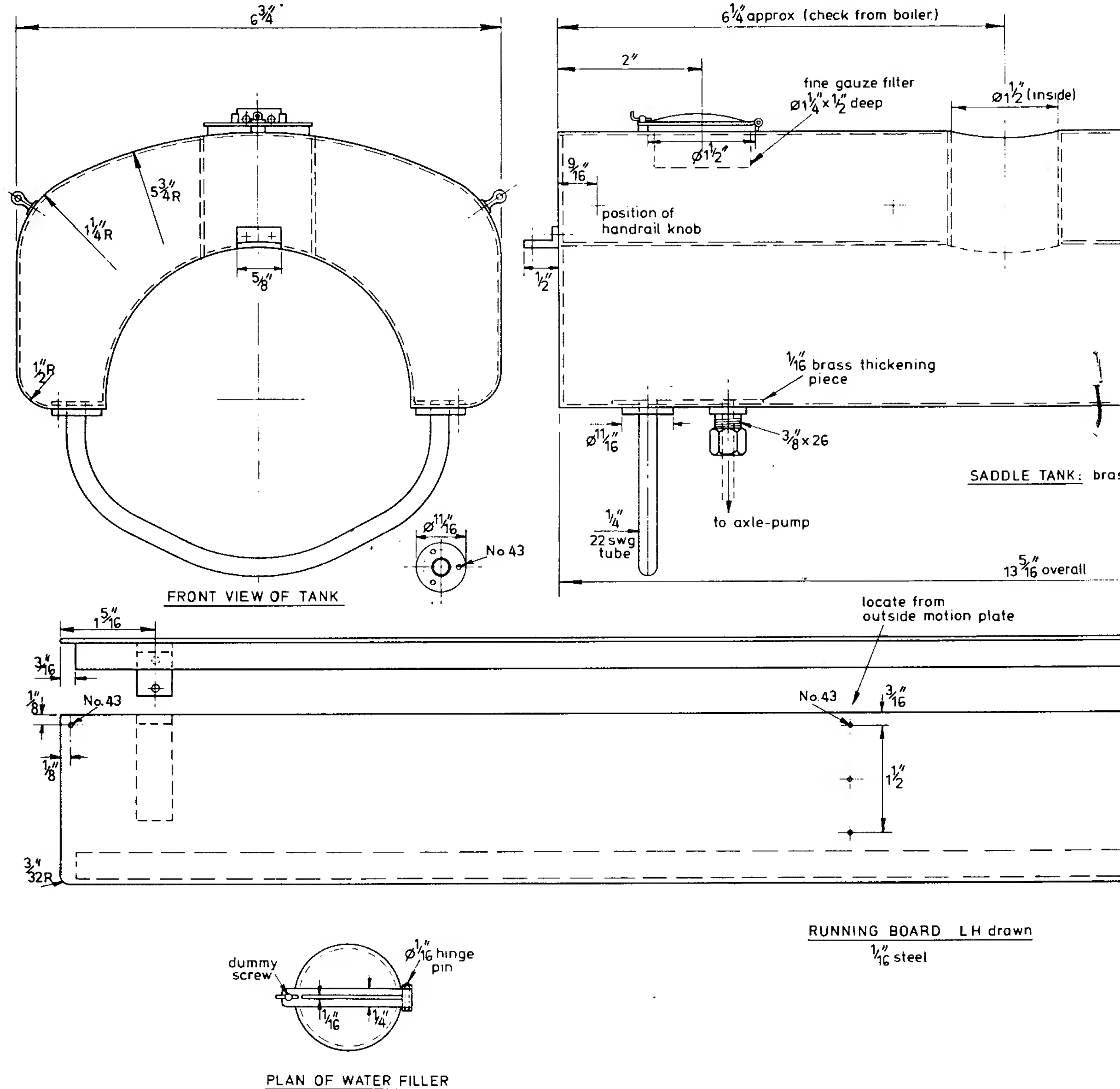
hardly worthwhile flanging the ends, as it is easier to fix the wrappers to the ends by brass angles, ¼ in. by ¼ in. by 1/16 in., using 1/16 in. copper rivets. I think it is advisable to make the end pieces first, so that we can be certain that they will fit over the lagged and cleaded boiler barrel. To get the brass angle to conform to the radii of the tank ends, make triangular saw-cuts into one leg of the angle at a pitch of about ½ in. then anneal. This is much easier than trying to bend the angle without the saw-cuts, especially where the top radii (1¼ in.) are concerned, and the angle won't be seen from the outside! To clear the dome, a length of brass tube 1½ in. inside dia. would be ideal, though if this is not available, the tube could be rolled up from the 20 s.w.g. brass sheet.

One important point: as all the joints inside the tank will have to be made water-tight, and soft soldering is probably the best way to achieve this, one end of the tank (preferably the rear end, as this will be covered by the spectacle plate) should be left off while all the other joints are sweated over. The rear end can then be assembled and held in position by a few brass screws. These screws should be put in with the heads well clear so that the heads can be snipped off and the screws filed flush with the tank. The join all round this end of the tank can then be sweated from the outside, though this part of the job can be made more certain if the angles around the periphery of the tank are sweated over with soft solder (just a thin film is enough) before fixing the tank end. And



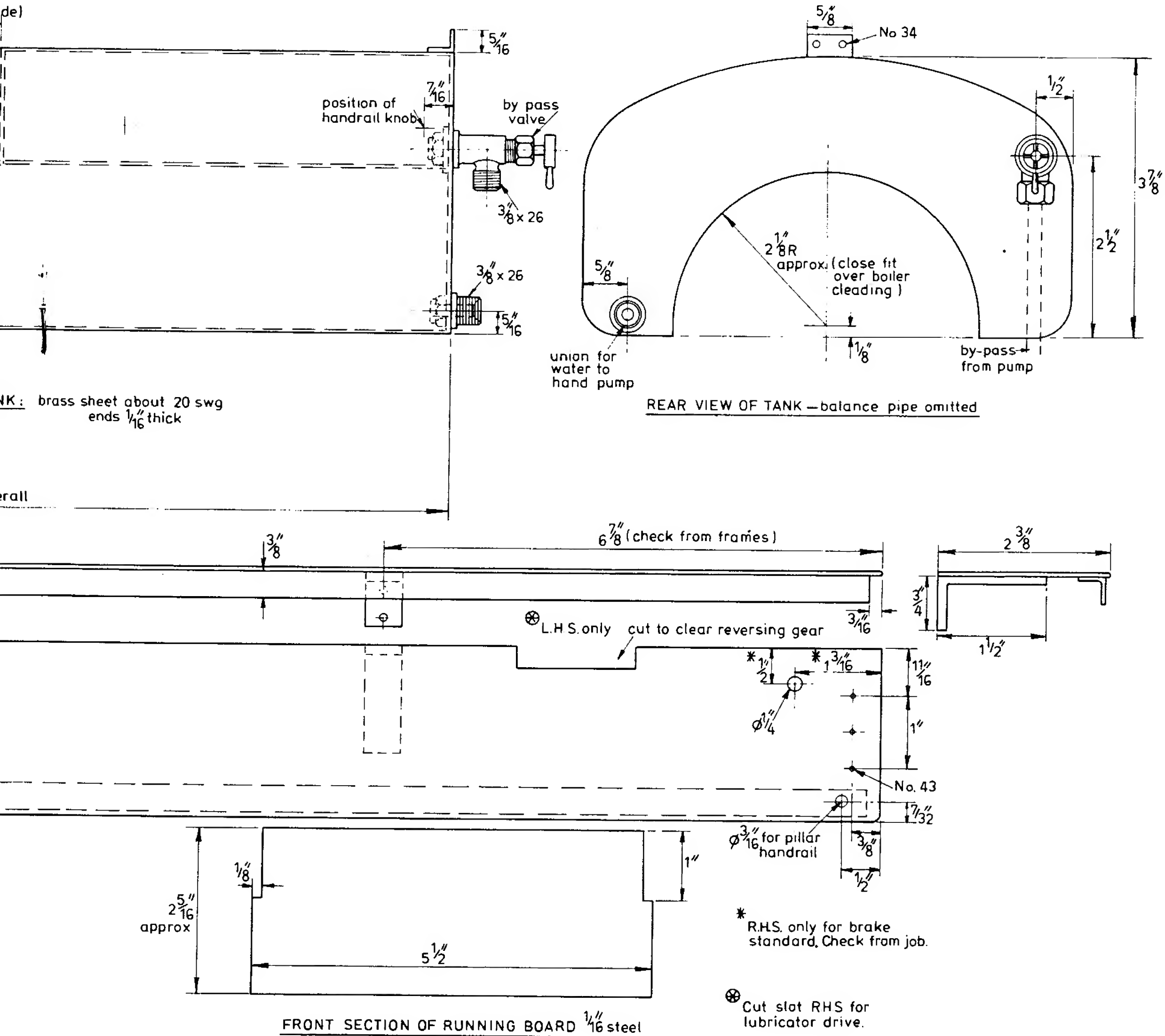
SPECTACLE PLATE (CAB FRONT)

1/16″ brass or steel



don't forget the thickening pieces (of 1/16 in. brass) on the inside of the tank where the flanges of the balance pipe are to be fitted, also the union from where the water is taken for the hand pump; these are essential as the 20 s.w.g. metal is far too thin to take even a 40 pitch thread. Incidentally, I have not included a drawing of a hand pump as almost any small pump of 3/8 in. or 1/2 in. dia. ram will suffice. There is, however, one important point to watch: as the hand pump is not submerged (as in normal locomotive side tanks or tenders) and as the water level in our saddle tank will be at a considerably higher level than the hand pump, it will be necessary to fit a screw-down valve or plug cock between this union and the pump, otherwise most of the water in the tank would flood the cab!

The saddle tank will need a "balance pipe", to connect up the two sides of the tank, and for this purpose a 1/4 in. dia. copper pipe is bent up to run just underneath the barrel, as shown. It is provided with flanges at each end and the screws through this are tapped through the tank bottom and the thickening piece above it. Hallite or similar gaskets will be needed at each flange, to prevent leakage. Some builders may prefer to use unions at each end of the bal-



REAR VIEW OF TANK — balance pipe omitted

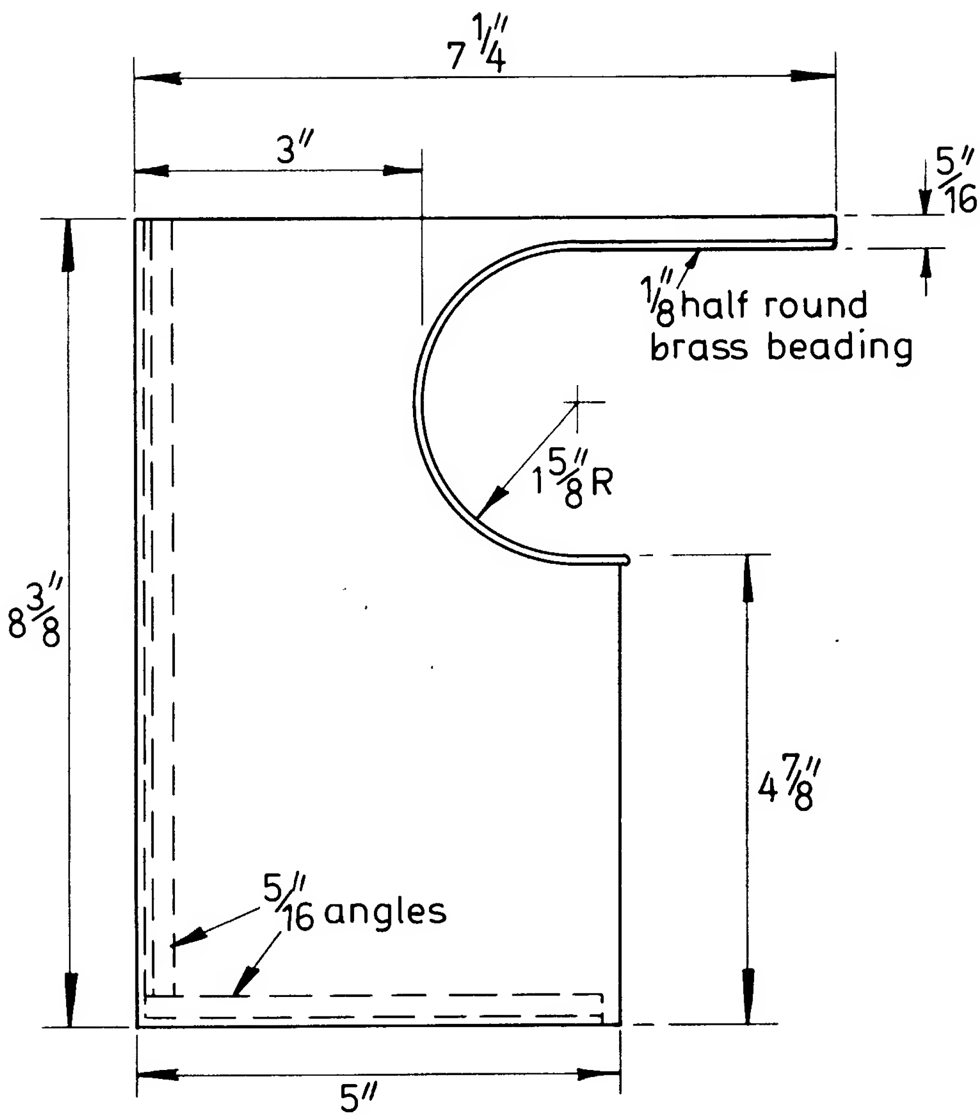
FRONT SECTION OF RUNNING BOARD 1/16" steel

ance pipe, as it is going to be a very tricky job getting at the screws in these flanges, as the balance pipe has to be assembled AFTER the tank has been put into position over the boiler barrel; it would be an easy job to screw these flanges in position if the boiler was first lifted off the frames, but who would want to disturb the boiler at this stage?

To hold the saddle tank firmly in position, short pieces of angle brass are fitted at each end. That at the front should be just long enough to bolt down on top of the smokebox, just behind the chimney. The rear angle bolts to the front of the spectacle plate.

Running Boards

As the running boards are rather long and are only supported at five points (two brackets, the outside motion plate and the front and rear beams) steel at least 1/16 in. thick is a must. It is stiffened by 3/8 in. angle for its full length. The left-hand running board will need a section cut out to clear the cab reverser, while the right-hand one will need a hole about 1/4 in. dia. to clear the brake standard. The vertical pillar handrail at the extreme corners of the engine are bolted through both the running boards and the 3/8 in. angle underneath, the tops of these being fixed to the



CAB SIDE
1/16" brass or steel

rear extensions of the cab sides. As the mechanical lubricator is mounted on the right-hand running board, a slot will be required in this to clear the lubricator driving arm. Above the running boards, at the cab end, we have another platform, which I am calling the footplate (for obvious reasons!) which, again, is best made from 1/16 in. steel. It is supported rigidly by 2 in. lengths of 1½ in. by 1½ in. by ⅛ in. steel angle, bolted to the engine frames. The footplate will need a section cutting out to clear both the mechanical lubricator and the reversing lever, and the brake standard is bolted to this and to the steel angle underneath it, thus making a very rigid fixing.

The Cab

I don't think I need say much about the cab, as it is of very simple shape. Make the front or spectacle plate first. This is in two halves, for easy assembly around the boiler barrel (the whole of the firebox

being inside the cab in this engine) with a vertical joint which can be made almost invisible with a little care, one side being flush riveted with 1/16 in. copper rivets, while the other, removable, side is held by a row of brass screws put in from the inside and filed flush on the outside. The spectacle plate will require cutaways for the rear end of the trailing wheel springs on each side, and on the left-hand side for the reach rod. Brass angle about 5/16 in. by 1/16 in. thickness should be about right to fix the cab sides to the spectacle plate and to the running boards. The cab sides look much better if some beading is put around their rear edges, and for this 1/8 in. half-round brass wire is suitable. If the cab sides have been made in brass, the beading can be soft soldered, using ordinary plumber's solder and a liquid flux such as the well known brand of Bakers'. The cab roof is of very simple shape, just the one, large radius, and may have a sliding section for driving purposes to the builder's choice. The hole for the safety valve cover should be made a close fit, while a "gutter" formed from brass angle about 5/32 in. section along the sides adds to the appearance.

Saddle tank filler or manhole. Most full-size engines of this type had some form of screw to hold down the lid. If made to a reasonable "scale" size, this would be too flimsy to be much use, so I suggest that this be made as a dummy fitting, and if the lid is made to overlap the filler slightly all around, there should be no real need for a positive fixing, the lid's own weight, if the hinge is "free", being enough to keep it shut. The filler should, however, have a narrow rim around the inside on which can rest a suitable strainer, made of fine wire mesh, to keep out the foreign bodies — not quite so important if no injectors are fitted, but still very much worthwhile!

Final Details

The handrails along the sides of the saddle tank can be the standard 3/4 in. scale type — 3/32 in. dia. stainless steel, and the knobs are quite cheap to buy so are hardly worth the trouble of making unless the builder is fond of making little drilling jigs! Some difficulty may arise in fitting these handrail knobs as they have to be fitted where the tank is of only 20 s.w.g. thickness, and it would be very difficult to get nuts on at the back. I think the best solution is to use another thickening piece — in this case it might be a strip of brass about 1/4 in. wide by 1/16 in. thick and the full length of the tank. This would, of course, have to be carefully positioned and soldered inside before finally closing the tank at the rear end, as previously described. The handrail knobs could then be screwed in from the outside.

The lookout windows or spectacles would look nice glazed with perspex about 3/32 in. thick, held in place by rings of polished brass and 12 BA brass roundhead screws.

Finally, readers will want to know how the "scale" driver manages *not* to fall off the back of the locomotive as she gets under way! Well, the answer to this very reasonable question is simply that I would rather leave this to each builder to decide for himself. Some kind of cab back will obviously be required when the locomotive is not being steamed, or for exhibition purposes, etc, but while driving, it is very convenient for the driver to have complete access to the cab by removing any backplate lock, stock and barrel! Most full-size narrow-gauge engines were very cramped on the footplate, coal was generally carried in a little bunker to one side of the firebox, so our 6 ft. drivers will not be so badly out of place if they carry their coal in a bunker fitted to the front of their driving car.

Painting

Obviously, each individual builder will have his own ideas about the livery to be adopted for his *Conway*. My own preference would be for a nice darkish green, not too glossy, but not "flat" either, with the usual parts black — smokebox and chimney, running boards, cab roof, outside of frames, etc. Front and rear beams, inside of frames, inside motion plate, feed pump and eccentric rods — signal red. Dome-polished brass, also chimney cap.

One final point before I sign off — as readers will understand, there is a great deal of work involved in getting out a design for any 3½ in. gauge locomotive, and preparing and checking eight large sheets of detail drawings, and as the best of us occasionally slip up, it is inevitable that one or two mistakes in dimensions will occur. So may I appeal to builders to let me know as soon as possible if they should discover any errors while at work on their engines, so that things may be put right, for the benefit of other enthusiasts. Good steaming! *(See 6 March issue!! — Ed.)*